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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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Foundry Technical Institute, Meek's Road, Falkirk (*Telephone 332*).

Forthcoming Events.

SEPTEMBER 6-12.
International Association for Testing Materials:—First International Congress at Zürich.

SEPTEMBER 10-26.
Shipping, Engineering and Machinery Exhibition:—To be held at Olympia, London.

SEPTEMBER 12-27.
International Foundry Exhibition and Congress:—To be held in Milan.

SEPTEMBER 13-18.
Institute of Metals:—Autumn meeting at Zürich.

SEPTEMBER 23-30.
British Association:—Centenary meeting in London.

SEPTEMBER 29-OCTOBER 2.
Iron and Steel Institute:—Autumn meeting at Swansea.

New Business.

Every industrial development, as also many artistic ones, have all had their repercussion on the foundry. Armaments created a demand for the largest types of castings for armour-plate-ingot moulds, rolling-mill parts and the like. The mechanisation of agriculture caused the creation of large foundries in Lincoln and elsewhere; whilst modern shipbuilding has brought into being a network of foundries round the Tyne, Clyde and Wear, and, of course, the motor car, likewise, brought a train of foundries in its wake. So the same story can be told of the rise of the Lancashire and Yorkshire textile industries, the railways, electrical engineering, printing machinery, municipal undertakings and their influence on castings requirements.

The question we wish to pose is: Can we see any developments in the near future which will give rise to an expanded foundry industry? There are at the moment several industrial activities which are gathering considerable impetus. Primarily, there is the motor boat, for just as the horse has been largely replaced on the roads, so it will be on Europe's gigantic system of canals, first by adaptation, and then by the redesign of the boats themselves. Simultaneously, the fishing smacks will discard the sail for the petrol engine as a preliminary to replacement by properly-designed motor boats.

A second development is the transformation of the city, town and village shop window and internal fittings. Already, to the Londoner, many provincial shop windows look just as old-fashioned as the small square panes of the village bow-windows.

A third development is of an all-embracing character, and is a result of the offering by specialty foundries of ranges of alloyed grey-iron castings for specific specialised duty.

In this last case, the founders will have to be astute to make their customers pay "steel-castings" prices for iron, but if they can offer a more satisfactory material for certain duties, adequate prices will be paid. When Sheffield, in 1900, first started selling high-speed steel at 2s. 6d. a lb., it was replacing material previously bought for less than 9d. Founders, however, first have to teach engineers such lessons as that "creep may be their greatest enemy, that rigidity is a blessing, and so forth."

A Remarkable Development.

Our readers will doubtless have read with interest the description we gave in recent issues of the plant at the Staveley works for the manufacture of cast-iron pipes by the centrifugal process in sand moulds. The illustrations serve to show how remarkable a gesture of faith this is in the future of the industry in this country. At the present time, many foundries tend to use the depression as an excuse for postponing development, whereas it is just the time when the extra leverage afforded by an improvement is most badly needed.

Spun pipes are, of course, not novel, much enterprise having been shown in the metal-mould development. The feature of the present development is spinning in a sand mould, whereby the cooling is slowed down and the necessity for annealing after casting is removed. Cooling, of course, takes place from one surface only, adjacent to the mould. The melting plant is remarkably complete, designed to work for 24-hr. periods, the facilities for weighing charges and depositing them mechanically in the cupola-charging door being exceptional. It need scarcely be added that, as in all plants where regular and continuous output is required, there is full scientific control at all points, for many problems require solution before a plant of this character functions as intended. It evidently embodies a vast amount of experience. The control of metal and of sand is unusually complete.

The progress of this plant will be watched with special interest, for pipes form a large proportion of the tonnage output of the industry, particularly of that going abroad, and there is no doubt that this country is now very well equipped for dealing with the demand for pipes. The Staveley Company is to be congratulated on its effort, and, having commanded success, we feel sure they will have earned it. The spirit behind this enterprise is one which might well be emulated by all other sections of the trade. No other section, of course, has need of spectacular developments on the scale shown here, but they have need for the courage and foresight shown, and the faith in the future of the industry. That, in fact, is the thing needed to ensure its future.

XUM

The British Cast Iron Research Association.

VII.—HOW THE ASSOCIATION IS GOVERNED.

The British Cast Iron Research Association is entirely self-governing, and whilst it has friendly and regular contacts with the Department of Scientific and Industrial Research, through which the Government grant is received, and regular relations with other Government departments, there is in no sense any measure of Government control, either of programme or policy. All the Department of Scientific and Industrial Research does is to nominate several gentlemen of distinguished scientific attainment to the Council.

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The Council is elected by members at the annual meeting and is representative of all sections of the trade. It is constituted as follows:—

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Dr. W. H. Hatfield (Brown-Firth Research Laboratories, Sheffield).

Mr. F. H. Hurren (Coventry Malleable & Aluminium, Limited, Coventry).

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Mr. E. Millington (London Midland & Scottish Railway Company, Derby).

Mr. John Shaw (Brightside Foundry & Engineering Company, Limited, Sheffield).

The Chairman of the Committee is Mr. W. H. Whitehouse, A.M.Inst.C.E., M.I.Mech.E., of the Heatly-Gresham Engineering Company, Limited, Letchworth.

(*Concluded on page* 124.)

Random Shots.

There's been much talk o' late of heavy-oil engines for road transport. And more than talk, as L.G.O.C. officials can tell you. Now, here's a Diesel-engined car making its mark on the race-track—and swiftly, too, at 109.16 miles per hour, for that speed it attained at Indianapolis some weeks ago. The course of 500 miles it covered at an average speed of 86.17 miles per hour, consuming 31 gallons of fuel oil and 1 quart of lubricating oil. Incidentally, it created the first record in the history of racing of a non-stop 500-mile run.

* * *

Pioneer fleets of heavy-oil-engined omnibuses and lorries are probably not farther off than just round the corner of 1931 (when, let us hope, business curves will rise to the occasion). I wonder, will ever a Diesel-engined "Blue Bird" leap the measured mile on Daytona Beach? The metallurgist and foundryman must have their say in an answer to that question!

* * *

The charms that music hath quite often fail lamentably to soothe the savage breast. In fact, they frequently inflame it. Saxophone players in adjoining flats, and out-of-doors wireless and gramophone enthusiasts, give these charms to the world freely, and in return are made the subjects of vituperative letters to the Press. "Marksman" himself, throughout the duration of his business hours, has an abundant supply of music, ranging from Hungarian rhapsodies to such ballads as "Don't Send My Boy to Prising." His thoughts upon itinerant street musicians are very hard at times.

* * *

Nevertheless, the provision of music in workshops during working hours appeals to me as being a sane proposition. Especially is this so in those shops where the workers have to perform a series of semi-mechanical operations with a certain rhythmic movement. The Westinghouse Electric Company, who have installed loud-speakers in the manufacturing departments of their Newark works, have found the scheme to work satisfactorily, and report that "the music is stimulating, offsets monotony, fosters contentment and brightens the work place." Again, the medical officer of Darwen states that music has a definite psychological effect on workers which increases the quality and quantity of production. Let us by all means have wireless installed in the foundry! [Right against the jar-rammers.—Editor.]

* * *

Postscript.—With the gracious permission of Miss Nellie Snookers (managing director), I hope to give you next week a brief description of the famous Gayway Foundry at Eastbourne.

Marksman.

Refractory Materials for the Induction Furnace.*

By J. H. Chesters and W. J. Rees.

(*Continued from page* 107.)

Micro-Examination of Lining Slices.

Figs. 5, 6 and 7 are micrographs of sections cut through a magnesia-zircon lining at the slag line. Fig. 5 shows the slag face, Fig. 6 a point about ½ in. in from the face, and Fig. 7 a point about ½ in. below it. Fig. 7 shows the altered zircon grains produced by heating the zircon in contact with magnesia, but very little sign of slag entry. Fig. 6 shows the entry of the slag and the absorption of the iron oxide from the slag by the magnesia grains. Fig. 5 shows the completely-altered material in the slag face. Sections cut at other points in the lining showed similar changes.

Basic linings show interesting changes with continued heat-treatment. The periclase grains change from rounded "raspberry-like" grains to a honeycomb formation, and finally to a cubic structure similar to that possessed by the electrically-fused material. It is, no doubt, this change which accounts for the cracking of basic linings. With magnesite of high-lime content the gradual crystallisation of a fibrous material is observed. The exact nature of these crystals is not known, but their optical properties suggest that they may be a lime silicate. Sections cut through silica linings are particularly interesting, since different parts of the lining are at different temperatures, and the long "soaking" period and steep temperature gradient through the lining cause the formation of zones of cristobalite, tridymite and unaltered quartz. The extent of these zones agrees essentially with that calculated from the known inversion temperatures.

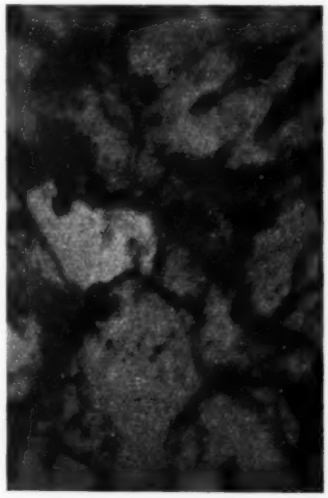

Fig. 5.—The Slag Face. × 170.

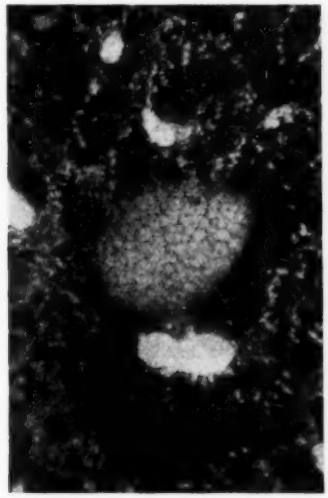

Fig. 6.—Zone immediately behind Slag Face. × 70.

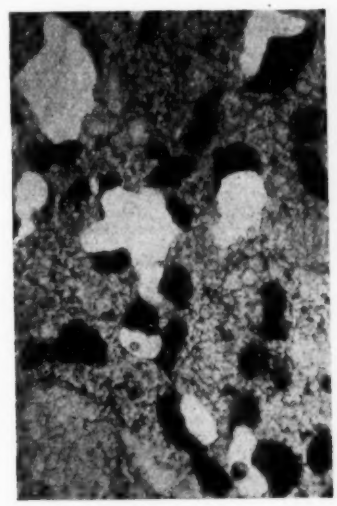

Fig. 7.—Zone ½ in. below Slag Face. × 70.

Figs. 5 to 7.—Micrographs of Sections through a 70/30 Magnesia-Zircon Lining.

The Lining Top.

Various users have different ways of finishing the top of the lining in coreless-induction furnaces. In some cases the liner is made to come above the level of the top of the coil. Other workers make use of a heavy iron ring which fits on top of a shorter liner, whilst in some cases the lining is finished off by moulding a top from a mixture of lining material and a strong solution of silicate of soda. The main requirements of the lining top are: (1) It must be strong enough to stop in position, and even to be used as a fulcrum for the tools used in levering the charge; (2) it must not flux or crumble seriously when the molten charge is poured over it; (3) it must make a good joint with the main lining.

If a material is to be rammed damp, and must not crumble or flux at any temperature up to the maximum to which it will be exposed, then it should possess a high-tensile strength over the whole working range of temperature. The tensile machine previously described by the authors was designed to determine the stability ranges of various bonds, such as silicate of soda, with a view to their use in lining tops. It was found that magnesia, crushed silica-brick, or firebrick, when bonded with silicate of soda, gave a material possessing high strength up to the fluxing point. Although the addition of silicate of soda lowered the hot strength—that is, the temperature of failure under a given load—the reduction was not great enough to prevent its use in a lining top. In certain cases where difficulty was met with in making a sound joint between the top and main lining, the use of an acid top on a basic lining was found useful.

Probable Developments in Induction-Furnace Linings.

If a lining lasts sixty runs—that is, about a week—then any further small increase in lining life is not particularly useful, since it is convenient to re-line the furnace at the week-end. Such linings are now available for the melting of ordinary steels, but with certain alloy steels—for instance, high-manganese steels—or when refining with highly-corrosive slags is attempted, a great reduction in lining life occurs. Thus, one basic-lining material, which was expected to do about forty melts on ordinary steels, only survived four melts under the severe conditions imposed by refining experiments. For such work more resistant linings are required. The factors which will tend to increase the durability of linings and on which experimental work is in progress may be summarised:

The use of materials of higher slag resistance may necessitate the use of purer and more refractory materials. Various materials, which as yet have not been used because of their relatively-high cost, may prove useful for special work where lining costs are not a serious factor. A reduction in the permeability of the material might be achieved either by better grading or by obtaining a higher sintering temperature.

There are three ways of giving a material strength at high temperatures:—

(*a*) *By the Use of a Bond.*—In such cases the strength of the lining is determined by the viscosity of the bond at a given temperature, and an increase in the stability range of the lining can only be obtained by the use of a more refractory bond.

(*b*) *By the Crystallisation of the Material, giving a Continuous Network of Crystals.*—This always occurs in silica bricks, the bond in silica brick being viscous at the working temperature. Magnesite does not appear to show this intercrystallisation of the grains, but is held together by the natural bond, which acts as a non-refractory cement. Thus, a rod of Austrian magnesite will break when heated to about 1,400 deg. C. under a load of 15 lbs. per sq. in., whereas a silica brick, under the same conditions, does not fail when heated to 1,500 deg. C. Electrically-fused magnesite, however, does stand 1,500 deg. C. under these conditions, and it is possible that intercrystallisation occurs. The higher the sintering temperature obtainable in making the lining, the greater is the chance of the occurrence of crystallisation.

(*c*) *By Heating Two Materials together to form a Compound which acts as a Bond.*—Magnesia and alumina may be heated together to give spinel. Such a reaction might result in the formation of a body of great hot strength. In the case of the magnesia-zircon work already described the resulting mineral is much less refractory than either of the constituents, and consequently its hot strength is low.

It will be seen from the above that great improvements might be expected with higher burning temperatures. Unfortunately the heat-treatment to which the lining is subject when using the Rohn method is limited by the melting point of the liner, although an increased sinter may be obtained either by holding the liner at a high temperature for some time before allowing it to split, or by keeping a molten charge in the lining for a considerable time.

There are two other ways of getting a better burnt lining—namely, by radiation with a graphite core, or by the use of pre-burned refractory shapes. The former method is limited to furnaces whose frequency is high enough to induction-heat such a core. Experiments are

(*Concluded on page* 114.)

* Paper read before the Annual Meeting of the Iron and Steel Institute in London.

XUM

Growth-Resisting Cast Iron for High Temperatures.

The manufacture of a growth-resisting cast iron has been recently described by R. Mitsche and O. von Keil.* From the views and experiments of other investigators, it can be concluded that growth in grey irons is due to the following causes:—(1) Decomposition of iron carbide, which is accompanied by an increase in volume, setting up stresses in the iron; (2) α-γ transformation, which loosens the matrix, thus allowing the oxidising gases to penetrate below the surface; (3) large graphite flakes which act as channels; (4) gas holes; and (5) certain alloying elements.

With repeated heating and cooling the decomposition of the iron carbide cannot be avoided. Therefore, a growth-resisting iron must have a matrix consisting of pure ferrite to commence with. Such a matrix is easily obtained with a high percentage of silicon. Experiments with irons containing various carbon and silicon contents (up to 12 per cent. of silicon) showed that with higher-silicon contents the stability of the carbide is not increased as is sometimes assumed.

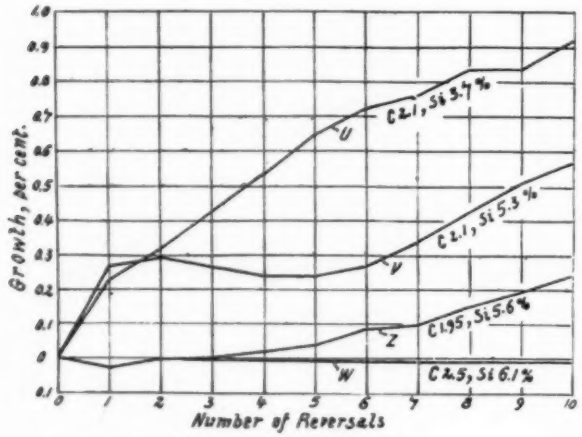

Fig. 1.—Growth of High-Silicon Grey Cast Irons during Ten Reversals of Heating and Cooling between 20 and 1,000 deg. C.

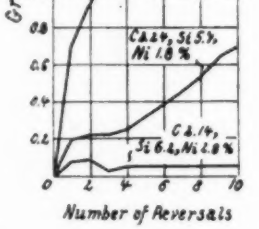

Fig. 2—Growth of Grey Cast Irons containing Nickel during Ten Thermal Reversals between 20 and 900 deg. C.

Regardless of carbon content, a ferritic matrix could be obtained with a silicon content of over 6 per cent., the results being practically independent of the wall thickness (0.787 to 1.575 in.). Further, the high-silicon content increased the resistance of the matrix to oxidation and the density of the casting. Part of the silicon can be replaced by phosphorus, which makes the iron more liable to graphitise and more easily running.

Table I.

Sample No.	Composition, per cent. C.	Composition, per cent. Si.	Quenching temperature, deg. C.
1	0.07	4.8	1,000
2	1.25	4.7	820
3	1.63	4.8	820
4	2.14	4.1	800
5	2.70	4.6	850
6	0.25	5.16	1,000
7	1.10	4.9	820
8	1.60	4.9	820
9	2.77	4.9	820
10	1.10	6.4	1,000
11	0.97	8.47	1,000
12	1.6	5.16	900
13	3.35	6.67	1,000
14*	2.6	5.8	1,000
15*	1.9	5.3	900

* Contained phosphorus also.

Table II.

Sample No.	Composition,* per cent. C.	Composition,* per cent. Si.	Transverse strength, tons/sq. in.
1	2.3	5.05	23.5
2	1.9	5.26	23.7
3	1.4	5.43	14.2
4	1.95	5.6	13.7
5	2.5	6.1	16.8
6	2.1	8.5	16.8

* The samples also contained Mn 0.3 to 0.4, S 0.1, and P 0.1 per cent.

With increasing silicon content, the α-γ transformation occurs at higher temperatures, and, with carbon-free alloys, is extinguished at about 4 per cent. of silicon. In order to ascertain the effect of the carbon content upon the critical temperature, test-samples, containing various carbon and silicon contents, were heated to different temperatures, quenched and microscopically tested on martensite formation. The results are recorded in Table I. At the quenching temperatures given no formation of martensite was noted, that is, the critical temperature had not yet been reached. It can be seen that about 6 per cent. of silicon is sufficient to raise the critical temperature to 1,000 deg. C. An elimination of the γ range also could not be established.

The form of graphite best suited for growth-resisting irons is the granular one, which is obtained with a definite phosphorus content. If, however, under the cooling conditions given, this form cannot be obtained, an acicular form as finely divided as possible must be aimed at by reducing the total-carbon content.

Repeated heating tests were carried out on irons containing various total-carbon and silicon contents. The diagram in Fig. 1 illustrates the growth of four of the irons tested during ten reversals of heating and cooling between 20 and 1,000 deg. C. With increasing silicon content the growth decreases notably, and is at zero with 6 per cent. of silicon. An iron containing T.C. 1.0 and Si 8.9 per cent. even showed a contraction of 0.8 per cent. during the first four thermal reversals. By adding 1.34 per cent. of phosphorus, alloy V was remarkably improved, a growth of 0.6 per cent. being obtained only with 36 thermal reversals. When this alloy was heated to 1,100 deg. C., that is, above the critical point, an additional increase in growth of 1.2 per cent. immediately occurred. From Fig. 2 it can be seen that nickel increased the growth when the silicon content was below 6 per cent. As the strength of cast iron decreases with increasing (C + Si)-content, transverse tests were carried out on bars 20 mm. (0.787 in.) in dia., which were broken at 400 mm. (15.75 in.) centres. The results recorded in Table II show that the transverse strength decreases up to 5.6 per cent. of silicon and then increases again. Impact tests carried out on bars 20 mm. in dia., tested in the as-cast condition, gave the results recorded in Table III. By adding nickel (up to 2.8 per cent.) no improvement of the strength could be obtained.

Table III.

Sample No.	Composition, per cent. C.	Composition, per cent. Si.	Impact strength, ft.-lb./sq. in.
B*	3.39	1.53	19.1
C†	3.44	1.82	26.6
1	2.1	3.7	28.0
2	2.1	5.3	23.3
3	1.0	8.9	13.1
4	1.8	10.4	15.4
5	1.8	11.7	14.5

* Engineering casting, containing also Mn 0.97 and P 1.07 per cent.

† Engineering casting, containing also Mn 0.72 and P 0.88 per cent.

Iron and Steel Output in July.

The National Federation of Iron & Steel Manufacturers report that the number of blast furnaces in operation at the end of July was 70, a net decrease of six since the beginning of the month, three furnaces having been damped down, four blown out and one having resumed operations. The production of pig-iron in July amounted to 317,000 tons, compared with 323,800 tons in June and 486,100 tons in July, 1930. The production included 77,300 tons of hematite, 116,700 tons of basic, 95,300 tons of foundry and 14,500 tons of forge iron. The July output of steel ingots and castings amounted to 428,700 tons, compared with 428,900 tons last June and 621,400 tons in July, 1930.

Refractory Materials for the Induction Furnace.

(*Concluded from page* 113.)

now in progress on the use of shaped, tongued and grooved bricks of both burned and unburned materials for the building of linings. The rapid rate of heating and the steep temperature gradient will impose a very severe strain on pre-burned materials, and spalling may be troublesome, but this may be overcome to some extent by the greater ease of patching. If the use of shaped bricks proves successful, the problem of the lining top might be solved in the same way.

The use of pre-burned bricks would simplify the problem of making linings for low-melting-point metals, where the temperature obtained by melting-out a liner of the same metal is insufficient to produce the degree of sinter required. The use of such shapes would also be applicable to the lining of induction-heated ladles, where the use of the Rohn method would be difficult, if not impossible.

* "Die Giesserei." 1931, No. 10.

Factors Influencing the Chilling Properties of Cast Iron.

When the Paper* bearing this title was presented by Dr. A. L. Norbury to the International Conference at Liége, it gave rise to an interesting discussion as to what causes cast iron to reproduce certain characteristics after remelting. The discussion was opened by Mr. Léonard, who said the question of graphitisation was important, because the complete solution would bring about a noticeable improvement in the quality of certain foundry products. The difficulties of manufacturing ingot moulds should not be under-estimated; it was a delicate and difficult operation which could, in a steelworks of average size, make or lose a small fortune, according to whether the ingot moulds were good or bad.

Many factors contributed to the result, the size of the graphite flakes being of great importance. Moreover, for the same composition, for the same casting, for approximately the same

Fig. A.—Iron containing Super-cooled Graphite, Pearlite and Phosphide, etched in Picric Acid. × 200. T.C., 2.33; C.C., 0.68; Si, 2.21; Mn, 0.98; S, 0.04, and P, 0.27 per cent.

running temperatures, for the same casting temperature, and on the test-pieces cast on to the ingot moulds, one might have, for identical amounts of silicon, total carbon and graphitic carbon, graphite flakes of completely different dimensions.

Influence of Cupola Practice.

The working of the cupola appeared to the speaker to be an influencing factor; this influence was well known in some foundries, but not in the majority. The percentage of coke, the blast pressure, the relative weight of the charges of iron were other factors found to have considerable influence. The use of special irons containing elements which tend to free the metal from oxygen, such as titanium, vanadium, ferro-silicon, seemed to cause a coarse-grained constitution, that is to say, make some contribution to the development of graphite.

Accepting Portevin's academic definition of cast iron—" a mixture of steel and graphite "—and taking into account the considerable oxidation which takes place in the open-hearth furnace or the converter, Mr. Léonard asked what was the degree of oxidation of the steel part of the iron, as oxidation which could arise from the blast furnace, from the cupola, being an hereditary factor influencing also the tendency to graphitisation. A deoxidised steel was more fluid than an oxidised one. Graphitisation should be enhanced in a more fluid medium.

Mr. Girardet asked Mr. Léonard if in his comparative tests he had examined irons from any angle other than the structural point of view.

Mr. Léonard replied that he had been forced to maintain the same conditions while working on irons of the same source.

Mr. Girardet said he asked this question because he had touched on it in his own Paper. From irons of the same source, as is well known, there might be an important kind of graphite present which was not generally considered, namely, kish.

Irons sometimes arrived from blast furnaces which were working irregularly, which were full of graphite; when the iron from the blast furnaces already contained graphite in suspension it tended to give a cast-iron product which was contaminated with large-sized graphite flakes.

When such an iron was cupola-melted, a certain amount of the graphite disappeared by simple decantation; another part remained in suspension in the liquid and promoted the development of coarse flakes of graphite which would seriously modify the strength properties of the iron. Consequently it would be necessary to examine, before making comparative tests, the qualities or state of the graphite pre-existent in the pig-irons.

Mr. Le Thomas submitted the main outline of an investigation which he was actually carrying out on the factors on which the chilling of iron depended—that was the point of view of heredity.

The results, when gathered together, completed and checked, would be the subject of a further report; the present remarks had no other aim than to make a comparison with the opinions put forward by Dr. Norbury and Mr. Léonard. They set out to define the tendency towards chilling in an iron and the factors on which it depended.

Carbon in iron existed in two states: (*a*) In the form of graphite, and (*b*) in the form of carbon, combined with iron carbide, Fe_3C.

(1) The disposition to chill characterised a tendency to form carbide rather than graphite under given conditions; it increased, and the iron tended to become mottled, then white, when (*a*) the carbon and silicon constants diminished; (*b*) the manganese content increased, and (*c*) the rate of cooling increased. These facts were well known in their entirety. The description of essential phenomena relative to the precipitations of graphite and carbide was made in the Paper " On some Physico-Chemical Considerations of Irons known as Pearlitic," presented at the Congress. The methods of measuring the tendency to chill deserved to be well examined and clearly defined.

(2) The tendency to chill depended also on other influences, less well known. An example would illustrate this point.

A turbine body was cast for which, by a regrettable blunder, very old iron balls were used almost exclusively. Their chemical composition corresponded with the required one (taking into account melting losses), but the structure was white; a mottled casting was obtained, which was unmachinable and suspected of being brittle. It was noticeable that an influence other than those elements generally measured could modify the tendency to chill; moreover, this experiment showed the existence of a particular property of the heredity of the iron, different from that which was relative to the persistence of the morphologic characteristics of the graphite, and which in practice it often superposed.

In a more general way the anomalies established in the founding industry relating to primary chilling[1] of irons, could be divided into two types: (*a*) An iron of normal composition, the white structure of which was due to a quick solidification, was remelted, followed by a normal cooling; the final structure did not show chilling.[2] In other words, in this case heredity of structure was not noticeable, if one considered only the last two forms of the product; but, on the other hand, the heredity appeared if one considered the structures obtained from the result of the melts followed by solidifications at normal rates; and (*b*) it existed in other cases where a white structure was obtained, as in the preceding example, in spite of apparently normal conditions of composition and cooling; if the product be remelted again, and be left to cool again at a normal rate, the white structure remained. All this happened as though a supplementary chemical element, working like a strong addition of manganese, for example, had been found incorporated in the iron, and remained in spite of fresh melts. It was as effective, in fact, as

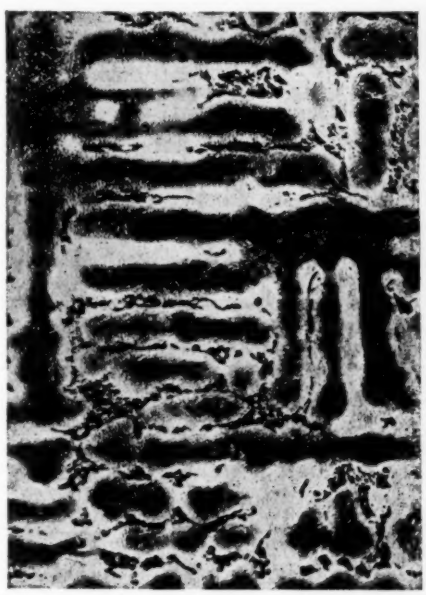

Fig. B.—Same Specimen as in Fig. A, etched in Cupric Reagent. × 200. Zoning Effect due to Variation in Concentration of Phosphide in Solid Solution in Pearlite.

chromium and other special elements, but one must admit that such influences were not to blame in the case stated. One must define what this factor of this heredity may be.

Probable Cause of the Character of Heredity.

(3) The element in question, it is thought, was in many cases oxygen incorporated in the iron in the form of iron oxide in solution. In fact, this opinion was not new, but was formulated by various observers in connection with incidents in manufacture; but a complete study of the phenomena had not been made, so far as the speaker knew. It should be remembered that the greatest quantity of FeO susceptible to solution in iron was about 1.1 per cent., equal to about 0.25 per cent. of oxygen (by weight).[3]

The experiments to be described were easy to understand, and well showed the sense of the phenomena.

* Published in our issue of July 17, 1930.

1 The expression " primary chill " is associated with the formation of cementite just as the expression " secondary chill " is relative to the formation of martensite.

2 A. Le Thomas. " Heredity in cast irons." C.N.T. 185, p. 1595.

3 Mathesius. " The Physical and Chemical Fundamentals of Ferrous Metallurgy," p. 343.

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(*a*) Taking an iron from a melting apparatus such as a cupola, the speaker made two equal portions for casting chill test-pieces. One of these pieces was cast after a small quantity of iron oxide had been added; its tendency to chill was increased. The other was cast without further treatment, and its tendency to chill was normal. The second portion was also cast after adding a little inert matter to cause an equivalent disturbance in the cooling; even in this case the special effect of the oxide remained evident. At the same time it could be said that the life of the oxidised iron was distinctly affected.

(*b*) One could work in the opposite way and deoxidise one portion of the iron by the addition of a very small quantity of an energetic reducer, such as aluminium or magnesium, or by passing over a bed of charcoal, as would be shown later. Quantitative experiments were, unfortunately, very tricky to carry out, for they demanded additions of dissolved oxygen, and it was well known how long and difficult such calculations were. But the general sense of the phenomena could not be doubted.

Finally, it must be admitted that the tendency to chill in an iron depended also, and to a very great degree, on the oxygen contents; but it still remained to calculate this relation.

Practical Applications.

(4) The speaker then cited several examples which showed how the above idea could be productive of results:—

(*a*) *The Case of Melting in the Cupola.*—One might point out that the passage through the cupola always tended to increase the quantity of iron oxide dissolved in the iron; but as this passage was rapid, this addition of oxide remained limited. It was known, moreover, in practice, that the tendency to chill of a known iron increased each time it was remelted in the cupola, and the phenomenon was more pronounced in that it did not result from the variation of the silicon content or other elements generally added. There was, indeed, "heredity," if one might call it by that name—not a pure and simple reproduction of characters, but a slow evolution in a definite manner; as one might say, it was that this heredity seemed able to vary as the oxygen content of the iron.

At the same time, the life of the molten metal was affected, and this characteristic seemed also to vary in the same sense as the content of oxygen in solution. If the cupola was "overblown," that was to say, if the air supply very much exceeded a reasonable maximum, the oxidation of the iron was greater and its tendency to chill increased very much, at the same time as the life of the metal decreased.

(*b*) *Irons Produced in Charcoal-Fired Blast Furnaces.*—The reducing action of charcoal was, generally speaking, greater than that of coke, and the different varieties of coke behaved differently in this respect. Bogitch[4] had shown, for example, that the rate of reduction of a solid oxide by charcoal was noticeably greater than the rate of reduction by coke. The speaker had carried out experiments which showed clearly that the tendency of an iron to chill diminished when the iron had been passed over a column of charcoal. This helped one to understand the reason why irons made with charcoal as a fuel showed peculiar characteristics, which recommended them for use in special castings; the special quality of these irons should be due partly to the fact that they did not contain oxide in solution, or they contained a noticeably smaller quantity than common irons.

(*c*) *Influence of Superheating on the Tendency to Chill.*—Iron contained, in solution, elements such as silicon and manganese, the combustion of which with the same quantity of oxygen gave more heat than the iron could give. Moreover, in the usual conditions of temperature and concentration, iron oxide remained in solution in the bath with these elements, provided they did not react among themselves. But if the temperature was raised sufficiently, the reduction took place, for example:—$2FeO + Si = SiO_2 + 2Fe$. These facts were well known as far as refining was concerned, in the converter or the open hearth. In ironfounding, the phenomenon of oxidation existed, nevertheless, in every instance, even in an atmosphere without free oxygen.[5] Finally, one might say that to obtain at least the partial disappearance of iron oxide in solution, by the simple action of silicon and manganese, themselves in solution in the iron, a higher temperature was necessary; it could easily be obtained in an electric or rotary furnace. Moreover, the action of superheating from this point of view was only effective on condition that the bath was not at the same time and in another way enriched with iron oxide, for instance, on account of an oxidising slag covering the bath.

He had purposely drawn attention to the fact that the present remarks dealt only with the conditions relative to the tendency of iron to chill, on account of the oxygen in solution. Of other actions, such as lamina of graphite, which remained through the melt and determined the heredity of graphite—as for these formations, they were independent of what he had set out to say. The two phenomena were both important.

It must be remembered then that these remarks did not pretend in any way to give a complete account of a question which was still being studied. He merely wished to take advantage of this Congress to give some indication of a category of phenomena which interested the founder in the highest degree.

"Supercooled" Graphite.

Mr. J. Shaw said although he was in agreement with the majority of Dr. Norbury's conclusions, he did not altogether approve of his working method. "Supercooled" graphite had never been produced, in the course of many experiments in a small cupola, with the materials specified by the author, and one could not help thinking that there was some strange factor at work in the melt in the crucible. It was true that a certain number of samples melted in the cupola revealed little areas of "supercooled" graphite, but the way in which they were produced was now known, and he thought that it was true to say that Dr. Norbury had not been successful in obtaining this structure in a metal produced in the cupola.

It was generally admitted now that there were factors other than those which were revealed by chemical analysis which could affect the structure and strength of the iron. The table below showed this very well; the tests were made in the normal conditions of manufacture; the metal was cast in well-vented moulds; the same quality coke was used in the same cupola; the bars on which the analyses and tests were made were of the same size, and the conditions of cooling did not vary very much. In removing the pig and the scrap, increasing additions of steel were made to each successive melt, the other elements remaining constant by the additions of alloys. Extra coke and a greater blast pressure supplied the necessary equilibrium of carbon. As is evident, the analyses were also as much alike as the working conditions permitted; and, moreover, the physical properties were almost doubled from the first to the last test-bar.

The question of the use of the chill test had been raised by Le Thomas. The true function of that test in the grey-iron foundry had nothing to do with the rate of cooling, but served only to give an indication before casting as to whether an unknown factor might have caused anything unusual. In every special case it was necessary to calculate a suitable analysis; as a result of experience one could say that under normal conditions in the cupola such a depth of chill would be obtained on a standard test-bar. Every serious variation warned the foundry foreman, before casting, that factors such as oxidation of the scrap already mentioned or an incorrect analysis of the pig and the scrap, or a serious error in the running of the cupola, etc., had caused the metal to be either too hard or too soft, as the case might be. If the variation in the depth of chill was great, it was the duty of the foundry foreman to decide whether or not the metal should be used. There was no doubt that the test for chilling revealed the harmful effect of oxidation of the scrap used in the course of the melting.

Tensile.	T.C.	Si.	C.C.	Mn.	S.	P.
Tons per sq. in.						
9.8	3.44	1.56	0.59	0.68	0.11	
10.0	3.46	1.60	0.56	0.65	0.114	Approxi-
10.9	3.41	1.93	0.51	0.76	0.103	mately.
13.4	3.43	1.49	0.63	0.71	0.113	
13.5	3.44	2.03	0.49	0.72	0.089	
14.9	3.43	1.98	0.53	0.74	0.11	Con-
17.6	3.35	1.49	0.60	0.76	0.12	stant.
18.1	3.36	1.47	0.56	1.20	0.103	
18.6	3.43	1.91	0.58	0.72	0.116	

Factors Influencing Graphite Structure.

Prof. Portevin said that the work of Dr. Norbury was of outstanding merit. He had shown with regard to the graphite size that from irons of the same chemical composition one can get different results, although he admitted that he was sometimes rather brief in his description of the way in which the irons were prepared. Among the factors the influence of which on the fineness of the graphite had already been recognised the following must be mentioned:—

(1) *The chemical composition*, in particular the carbon content; the higher the carbon content the coarser the graphite tended to be, other things being equal; the action of silicon and nickel depended on the carbon content; for low carbon contents one could refine the graphite by increasing the silicon. Certain special elements, such as chromium, always refined the graphite. In experiments having for their object the study of the influence of other factors, and notably the thermal history in the liquid state, one must verify by careful chemical analysis the final variations of the chemical composition of the iron.

(2) *The rate of cooling* and, in consequence, the thickness of the casting.

(3) *The super-heating* or, more exactly, the thermal history in the liquid state, whose influence the speaker predicted in a Paper to the previous International Congress of Metallurgy at Liége in 1922, as a consequence of equilibrium in the liquid phase.[6] Equilibrium must be considered not only in relation to the carbon content, but in relation to all the elements present, including sulphur and oxygen.

(4) *The initial size of the graphite in the metal bath.* It had been pointed out on several occasions that irons with large graphite flakes (open grain) gave after fusion more fully-developed graphite flakes. This hereditary influence of the graphite could be explained by its incomplete solution in the cast metal and the persistence in the latter of crystallisation germs, as he had indicated.[7] But this phenomenon of heredity, far from being limited to very coarse graphite and rapid fusion in the cupola, must, on the contrary, be generalised. The following factors must be added to those which had just been enumerated and those which were the result of studies carried out in conjunction with Mr. Lemoine.

(5) *Initial state of the carbon in the metal bath.* In order to obtain fine graphite one must

4 Bogitch. "Researches on the reduction of mineral oxides." Revue de Métallurgie, 1928, p. 247.

5 See the diagram given by Bauer and Geösaner "Métallurgie Générale," by Leon Guillet, p. 238 (Publisher, Baillière).

6 A. Portevin—Revue Univ. Mines, 6th series, XV, pp. 225–252, 1922.

7 A. Portevin—Discussion on Adamson's Paper before the first International Foundry Congress, Paris, September, 1923.

start with a metal bath containing no graphitic carbon, that was to say, white iron and steel, and the effect of the superheating in the liquid state might be different according to whether one started off with white iron or steel. This was one of the reasons for the non-agreement of the conclusions put forward by various authors concerning the liquid superheating and the heredity of cast irons.[8]

(6) *Conditions regarding the addition of silicon*, that was to say, the nature of the addition and the temperature at which it was made. The intervention of this factor, which had not previously been mentioned, was not surprising if one recalled all that had been said concerning the equilibrium in the liquid phase.

It would seem, from experiments made in conjunction with Mr. Lemoine, that the most favourable conditions for refining the graphite were the employment of a high silicon alloy or of ferro-silicon of low silicon content added in a hot, slightly decarburised bath. There would either be an exo-thermic reaction or dilution.

One could thus obtain irons with a dendritic structure with graphite eutectic in between the dendrites, which Norbury called "supercooled graphite," to distinguish it from the pseudo-dendritic or normal graphite, without indicating, however, in a clear and precise manner the conditions under which one or the other form was obtained. Although Norbury said that graphite eutectic, or supercooled graphite was mixed with ferrite, he had seen graphite eutectic irons which only contained pearlite, but that pearlite had much larger lamellæ than that forming the dendritic silhouettes. By annealing one easily got the ferrite-graphite eutectic mixture by graphitisation of the coarse pearlite which accompanied the graphite eutectic. Moreover, copper etching reactions indicated a very clear difference of attack between the two categories of irons by causing varying depths of colour between the centre and the periphery of the dendrites.[9] Sometimes one could encounter a structure having ferrite dendrites with graphite eutectic and pearlite, a stable equilibrium which one could also produce more or less completely by annealing.

On the other hand, when there was a mixed structure, that was to say, when two varieties of graphite were present, the graphite eutectic appeared in the ferrite. This mixed structure corresponded to unfavourable mechanical results; he was in agreement with Norbury and Pearce on this point, but he was awaiting some new results before expressing an opinion on the mechanical properties of pearlitic irons having graphite eutectic and dendritic structure. Moreover, in a general way, if the thermal history of the liquid charge could have an influence, its chemical history and equally the final chemical composition appeared to be far from unimportant. In particular, it seemed that the results were not the same if one worked with constant carburisation as if one effected a decarburisation starting from a highly carburised charge. This would not surprise those who were well acquainted with the manufacture of wrought steels and the influence of all the particulars of their operation. It was, moreover, to be noticed that irons prepared in the electric furnace showed fine graphite and a quite remarkable structure.

The President said that the Papers of Dr. Norbury and of Mr. Lemoine, as well as the contribution of Prof. Portevin, formed a really remarkable whole, which threw altogether new light on the question of graphitisation. There would certainly be revealed, in studying the phenomena thoroughly, the means of considerably modifying the structure of cast irons.

[8] In speaking, as Mr. Le Thomas has done, of two grey irons with graphite flakes of different sizes, but coming from the same grey iron in the first place, it is quite natural to obtain, after remelting under the same conditions, products seeming as though they had identity of origin to the second generation.

[9] The dendritic structure of the iron is visible, not only on the polished and etched surfaces but on the fractures.

AUTHOR'S REPLY.

Dr. A. L. Norbury (in reply) wrote there was general agreement among those who took part in the discussion that there was some factor or factors in addition to chemical analysis which could produce marked differences in the properties of grey-iron castings. Mr. Léonard suggested that variations in the working of the cupola could produce such differences. Mr. Girardet suggested that the graphite structure in the pig-iron used could produce such differences, and with both of these views he, the author, agreed.

With Mr. Le Thomas, however, who suggested that the above differences were due to oxygen dissolved in the melt, he did not agree. He had made a number of experiments in which iron oxide was stirred into molten cast iron ("The Effect of Melting Conditions on the Microstructure and Mechanical Strengths of Grey Irons containing Various Amounts of Carbon and Silicon," Journal of the Iron and Steel Institute, No. 1, 1930), but found that the oxide reacted with the manganese and silicon and carbon present to give slag and gas bubbles, and was completely removed in this way in a short space of time, if the metal was reasonably hot. This was what would be expected from knowledge of the fact that in the case of steel small additions of manganese or silicon were sufficient to ensure complete deoxidation. The same thing occurred in the case of cast iron in which the manganese, silicon and carbon contents were usually much higher than those of steel, and consequently caused more rapid deoxidation. Differences in mechanical properties and tendency to chill in irons of the same chemical analysis were, in his opinion, due to differences in the size of the graphite flakes and not to the presence of oxide.

Recently he and Mr. E. Morgan had carried out the following experiments:—Specimens of an iron which contained only supercooled graphite in its structure (total carbon 2.5 per cent., silicon 4.5 per cent., manganese 1.0 per cent., sulphur 0.03 per cent., phosphorus 0.03 per cent.) were remelted in an alundum-lined crucible at about 1,400 deg. C., and under these conditions always gave structures containing only supercooled graphite. Remelting in an alundum crucible and stirring in iron oxide failed to coarsen the graphite structure, but remelting in a graphite and fireclay crucible, however, had a marked effect in producing normal relatively coarse graphite flakes, especially where the molten metal had been in contact with the graphite in the crucible.

Mr. Shaw stated that he was unable to produce castings containing large amounts of supercooled graphite from cupola melts, and suggested that other factors than those obtaining in crucible melts must be at work. This was undoubtedly the case. The presence of coke in contact with the molten metal was probably one of the chief differences, and would have a considerable effect in coarsening the graphite. There was, however, a number of cupolas working in England, particularly those which gave very hot metal and which used considerable percentages of steel in the charge, which produced castings containing considerable amounts of supercooled graphite.

In connection with Prof. Portevin's summary of Mr. Lemoine's Paper, it might be recalled that homogeneity of mechanical properties between thick and thin sections could in some cases be assisted by additions of nickel, which reduced the chill in thin sections and thereby softened them and at the same time refined the pearlite in the thick sections and thereby hardened them. The same effect could be produced, although not so conveniently, by increasing the manganese and silicon contents in the correct proportion. The fuller information required by Prof. Portevin regarding the melting conditions under which the normal and supercooled graphite structures were produced, were given in a later Paper (Journal of the Iron and Steel Institute, No. 1, 1930).

Prof. Portevin's application of the cupric etching reagent to cast iron was extremely useful. As in the case of steels, the reagent etched that part of the pearlite which was low in phosphorus, but did not etch the pearlite which contained phosphorus in solid solution. In the irons referred to by Prof. Portevin, the phosphorus content appeared to be very low (*i.e.*, probably below 0.05 per cent.), and in the case of the supercooled-graphite iron shown in Figs. 4–7 the phosphorus appeared to be confined to the graphite eutectic, and was apparently not present in sufficient quantity to be also present in the pearlite dendrites. In supercooled-graphite irons of higher phosphorus content, however, the phosphide was also present in the pearlite dendrites, as shown by the photomicrographs in Figs. A and B, which were of an iron containing supercooled graphite together with 0.27 per cent. phosphorus. The cupric etching reagent used was that proposed by Rosenhain and Haughton.

He (the author) had never said that supercooled graphite was always associated with ferrite, only that supercooled graphite tended to graphitise the surrounding pearlite to ferrite much more readily than normal graphite did. Supercooled graphite was, in fact, usually associated with pearlite in irons in which the silicon content was low or the total carbon content low, or those in which the pearlite was stabilised by sulphur not neutralised by manganese (cf. Fig. 30, p. 467, Journal of the Iron and Steel Institute, No. 1, 1929), or by manganese or by chromium.

In the case of the iron shown in Fig. A, it was the very low total carbon content of 2.33 per cent. which was chiefly responsible for the supercooled graphite being associated with pearlite rather than ferrite. This iron contained no graphite coarser than that shown in Fig. A, but only gave a tensile strength of 21.8 tons per sq. in. on a 1.2-in. bar, turned down to 0.798 in. It was probable that a strength figure several tons higher would have been obtained on an iron of the same analysis containing normal graphite flakes.

The Association of Special Libraries and Information Bureaux.

Eighth Annual Conference.

The Association of Special Libraries and Information Bureaux is holding its Eighth Conference at Lady Margaret Hall, Oxford, during the week-end September 18-21, 1931; the Conference will begin on the Friday evening (September 18) and will end immediately after breakfast on the Monday morning (September 21).

In allotting accommodation preference will be given to members and associate members of ASLIB, but in as far as is possible the Conference will be open generally to all interested, whether they are members of the Association or not. The inclusive charge for the week-end to members and associate members of ASLIB and their wives is £3. Non-members of ASLIB will be admitted on payment of a special fee of £4. These fees include rooms and meals in the College, gratuities, Conference charges, and a copy of the Conference Report. Reduced fees for short periods may be arranged with the Secretary.

Those intending to be present should write to the secretary of the Association, at 16, Russell Square, London, W.C.1.

At a meeting of the Works Committee of Dundee Town Council, on August 10, it was agreed to accept the tender of Messrs. Redpath, Brown & Company, Limited, amounting to £6,375, for the erection of the steel work for the east and west wings of the city square.

The Potentialities of South American Markets of Cast-Iron Pipes

By R. E. Flinn.

From the statistics published in the "Annual Statement of the Trade of the United Kingdom," dated 1930, it is difficult to ascertain both the exact tonnage and the value of cast-iron pipes shipped from this country to South America. It is quite clear, however, from the figures given for the years 1928 and 1929, only two of the South American republics purchased cast-iron pipes from the United Kingdom in any considerable quantity. The two republics in question are the Argentine and Uruguay.

Two other countries only are mentioned in these statistics as having bought cast-iron pipes from Great Britain, namely British Guiana and Ecuador. Ecuador totalled 15 tons during the two years in question, and British Guiana 1,286 tons. Why Chile and Peru, to mention only two of the other republics, should not buy cast-iron pipes from us when both Uruguay and Argentina do so quite extensively, is not apparent.

Both Chile and Peru, nevertheless, imported from Great Britain during the period under discussion, both wrought-iron and steel pipes; Chile to the extent of 3,180 tons in 1928 and 7,871 tons in 1929, and Peru 2,005 tons and 890 tons in the same years. This is curious, as the duties on cast-iron pipes both in Chile and in Peru are half the amount of the duties on wrought-iron and steel pipes. The inference, therefore, is that what cast-iron pipes were purchased by these two countries were obtained from other sources and at cheaper prices than those quoted by British manufacturers. The following details embody a brief summary of the prospects of business in the more important of the South American countries:—

Chile.

Chile has in the past spent enormous sums on pipes which are used in connection with the mineral industries of the desert. Potrerillos, a large copper centre, obtains its water from the Andean snowfields 60 miles away. Most nitrate plants and many coastal cities of Northern Chile receive their water supply through pipes from the higher Andes, 100 miles distant. There remain, however, unlimited possibilities for pipe manufacturers, inasmuch as more irrigation is required to develop the agricultural lands, and both drinking water and drainage must be supplied to many cities.

Peru.

The sanitation programme of the Government, involving the sanitation of all the principal cities, has already begun. In the case of Lima, Arequipa and Cuzco the work has virtually been completed. New water supplies have also been provided for these cities, and all these installations were undertaken by an American firm, and the materials employed being imported exclusively from the United States. Many similar works, however, remain outstanding for future development.

Pipes are also required in this country for irrigation purposes. The Peruvian Indian is an expert at turning a desert into a garden, provided he is supplied with water. The most important agricultural section of the country by reason of its accessibility is the desert coast line 1,400 miles in length, with a littoral up to 60 miles wide, intersected by various small mountain streams. Of this area about one million acres only have been brought under irrigation and cultivation. Other new irrigation schemes are scheduled to be undertaken by the Government for the further development of the area in question.

Ecuador.

The estimate for Public Works for 1931 is roughly £500,000. Of the works under contract the chief ones are the sanitation of the port of Guayaquil by a British engineering firm. The same contractors are also in charge of the works at Esmeraldas, consisting of water-works and electric-light plants. The public works undertaken directly or indirectly by the Government become more important from year to year. The Consul-General at Quito states in his latest report that "It would be satisfactory to note a greater interest in these enterprises by British firms." The duty on cast-iron pipes in Ecuador as in Chile and Peru is less than on wrought-iron or on steel pipes.

Colombia.

Perhaps the chief customer for cast-iron pipes will prove to be the Government itself. For Government business, a good representative in Bogotá is indispensable, and for national distribution the best arrangement is the appointment of a Bogotá agent, with branches in other cities of the Republic. The purchase of all materials and the letting of all contracts with national public works is in the hands of various purchasing bodies in Bogotá, chiefly the Ministry of Public Works. The capital is the purchasing centre, not only for the Municipality and Departmental Governments, but for the National Government, which is by far the largest purchasing entity in the Republic; furthermore, the city is the largest in the country, and the market for the most populous and extensive region of the Republic. There are many schemes on foot throughout the country for drainage and sewerage and water works. The growing oil industry will be calling for pipe-lines in the near future.

Venezuela.

This is now the second largest producer of oil in the world. There is good demand for piping in the Maracaibo district for use in the petroleum fields. In this district piping for water is subject to oxidation, due to salt in the atmosphere and attributable also to chemicals in the local sand. It may be of interest to mention here that the United States during 1928 and 1929 exported iron and steel pipes to this Republic to the value in sterling of £2,100,000. The United Kingdom's contribution during the same period amounted to £155,000 only.

Brazil.

The population of this vast country is now forty millions. This figure shows an increase of, roughly, ten millions during the last ten years. The large cities are extending their boundaries by leaps and bounds, thus calling for new water supplies and drainage schemes.

The Rio municipality is confronted with two serious problems, which are engaging the special attention of the technical authorities. They are respectively the extension of the water supply and the effective drainage of the town in order to avoid the frequent flooding of the low-lying sections during the rainy seasons, when enormous volumes of rain water, heavily charged with earth, come down from the surrounding hills. The writer himself has on one occasion seen the famous Avenida Rio Branco knee-deep in water, which rushed through the town like a mountain torrent. In the neighbouring city of Nichteroy a contract for a water supply, involving the purchase of a considerable quantity of piping, has been held up owing to the unexpected appearance of salt water in the area of the scheme.

Work has been commenced on the water supply of Bahia, and an order for pipes was placed with the Usines Pont à Mousson of France. The drainage system has not as yet been tackled; this, however, will receive attention after the water-supply system has been completed. With a view to entering into business relations with the Government, it should be noted that the present administration has instituted a central purchasing bureau for the purchase of all Brazilian Government stores. By this means all States and municipalities, instead of issuing their orders for material independently, as they did formerly, will now have to send in their requisitions to this bureau in Rio de Janeiro.

Uruguay.

As probably most of the business, apart from the British-owned companies, will be done with the Government, it is imperative for British firms competing for Government contracts to be represented locally, although it is not necessary for their names to be registered locally at various Government offices in order to permit of their tendering. The importance of choosing the right type of representative cannot be over-emphasised. Not long ago the Montevideo Water Works ordered 23,000 tons of piping, consisting of 29 miles of 36 in. dia. new main and 40 miles of distributing piping. This order was placed in England.

Argentina.

In 1929 the importation of cast-iron pipes from Great Britain totalled 24,222 tons. Further large quantities of pipes are required for drainage and water works. According to a decree, dated February 14 this year, which deals with alterations in the tariff, a number of articles are to be admitted duty free into the country. Amongst these figure "machines and mains for public gas or electric-lighting supply, water works and sewers." Another decree, issued by the Ministry of Public Works, allocates a sum for a survey of water-power possibilities in eight Argentine provinces and in the territory of Los Andes, in which it is intended to provide irrigation works, etc.

From the foregoing it is clear that there are possibilities of business in South America for British manufacturers of cast-iron pipes, but orders must be sought for on the spot, preferably by local agents supported by a factory representative, who must be able to speak both Spanish and Portuguese.

Publication Received.

Aluminium in Shopfitting.—Published by the British Aluminium Company, Limited, Adelaide House, London, E.C.4.

When we picked up this book from our desk we thought it was a duplicate copy of "Aluminium in Architecture and Decoration," and we were particularly pleased to find it a companion publication. However, much that we said in reference to the latter applies with equal force to the former, especially in the direction of its being suggestive to foundry owners of new outlets for their products. Actually, the average aluminium foundry owner is far too tied-up to the automobile and aeroplane industries to be healthy. One prominent aluminium foundry owner nearly "crashed" during the slump which followed the post-war boom. Where we are situated in the West End of London, we cannot fail to be impressed by the rapid strides which aluminium and stainless alloys have made as *materia decorare* for shops and theatres, yet when we visit foundries we invariably see crank-case covers and the like. Paris is probably even more plentifully supplied with aluminium shop fronts and fixtures than London, and here we learn that maintenance services have been established for their preservation and upkeep. If we interpret the trend of fashion correctly, this movement will spread to Wigan, Rotherham and Falkirk, and the value of the orders will certainly be considerable. This book, which contains 42 well-illustrated pages, can be regarded as being complementary to the one on architectural applications.

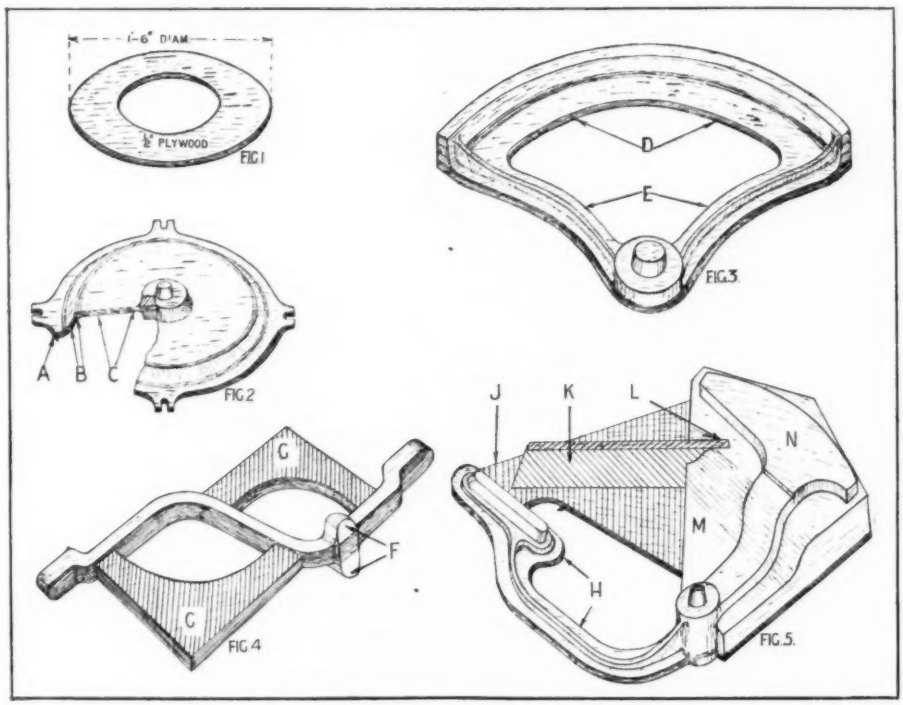
Plywood in the Patternshop.

By F. C. Edwards.

All patternmakers know the value of segments. By gluing together a number of pieces of wood in such a manner that the straight, stable grain of one piece is utilised to control the possible warping tendencies of its neighbours, an interlocked, dependable whole is secured. By this method, almost every conceivable shape—minute or gigantic, multi-angled or poly-planed—can be made to "stay put." The corrective interaction of a multitude of segments neutralises potential evils and produces a reliable structure.

But building up patterns with segments takes time. Even with a sharp band saw and a newly-ground trimmer (both rare birds—especially where it is everyone's business but no one's duty to keep them in order), to build up three or four rows of segments normally occupies, say, ten times as long as it would take to cut out a similar piece from the solid board. Then the glue must be given time to set, which holds up the job several hours—unless one is prepared, of course, to expose one's head to the mercy of segments in flight! (Those who have heard the "machine-gun" rat-tat, as successive segments have escaped from bondage, assisted by the combined agencies of imperfectly-set glue, an ill-guided lathe tool, and centrifugal force, will know what this means.)

It will now be seen that segmental construction involves the expenditure of much time and labour in the patternshop. And although prodigality here—a creative department correctly so termed—is often the only means of attaining the desired result, the patternmaker must be constantly on the look-out to combat all unnecessary expense.



Figs. 1-5.—Patterns Made of Plywood.

Plywood has no "Short Grain."

At this point some significance must be given to the title of this article: "Plywood in the Patternshop." As stated, one can normally cut from the solid board the shape required in considerably less time than would be necessary for building up the job in segments. But the ordinary board—yellow pine is here referred to—seldom exceeds, say, 11 or 12 in. in width, and a piece cut out in the nature of a ring is almost certain to warp and shrink. It is, furthermore, notoriously weak "across the grain." Plywood, however, is a material that is, to all intents and purposes, unlimited in width and length, with a useful range of thickness, whose multiple laminations of different grain-orientation serve the purpose of segments. Plywood, moreover, has no "short grain"; it is equally strong and serviceable in every direction, and its regular laminations incidentally furnish convenient depth stages in cases where patterns require to be recessed.

But plywood is a comparatively recent innovation. Most patternmakers learnt their trade before it came into general use. As a consequence, it is not used as extensively in the patternshop as its potentialities merit. This is not to say that the skilled patternmaker deliberately looks askance at the new material, but having acquired a mastery over his craft with ordinary timber, it simply does not occur to him to make use of plywood. What he needs, of course, where segments are concerned, is "a new way of thinking"—it is "the first step that counts."

Making a Plain Ring Pattern of Plywood.

Consider now some examples of the use of plywood in the patternshop. Fig. 1 illustrates a plain ring pattern, 1 ft. 6 in. outside dia., 9 in. inside dia. and ½ in. in thickness. By the orthodox, segmental method, it would be necessary to build such a pattern in two—or, for a first-class job—three rows of segments of, say, six segments to the row. The template for the segment would first be prepared with allowances for trimming and fitting each end, and for truing up the job in the lathe inside and outside. Each segment would then be marked and sawn out, fitted and glued in position, the glue allowed to set, and the pattern turned up to the sizes required. Compare with this the plywood method. Both diameters are marked out on a sheet of ½-in. plywood. This thickness, by the way, is made up of seven laminations—virtually seven continuous rows of segments—with unimpeachable joints held together by waterproof glue, perfectly set.

If a pattern of this type is to produce a casting which is required to be machined all over, it is simply marked out with machining allowance, the inside is removed with a jig saw and the outside band-sawn—the table, in each case, being slightly canted to give taper to the edge Then—since plywood finishes comparatively smooth off the saw—sandpaper and varnish complete the pattern. If the casting is not to be machined, and strict accuracy is required, allowance is made in sawing out the ring, and it is turned up in the lathe in the ordinary way. Such a pattern is not only quickly made, but will be found very durable.

Further Examples of Plywood Patterns.

A composite example of segments and plywood is seen in the coverplate, Fig. 2. Here, the bottom flange, A, 2 ft. 6 in. in dia. overall, was cut from a sheet of ½-in. plywood, the centre (of the flange) jig-sawn out, and three rows of segments, B, built up on this to provide the required depth of crown. Thanks to the generous slope of the dish (a fine moulding feature), the centre piece sawn out of the flange was used to form the top plate, C.

The quadrant pattern—Fig. 3—again, was formed with a plywood base, D. This saved the time of halving and gluing-up the plate, unavoidable in using ordinary timber. It would have been futile, of course, to have cut the job from an ordinary board because of the "short grain" weakness at the arms, E, and the general tendency of such a plate to shrink and warp. In this case, too, segments were used to form the outside rim.

It is a common occurrence (too common, perhaps, from an economic point of view) for the patternshop to receive a blue print with the accompanying information that the job "must be cast to-day!" In some cases, of course, there is no difficulty in carrying out the order. The foreman simply "switches" over a man—or a dozen men, according to the magnitude of the job—and, *presto*, delivery is assured. Where the combined labours of several patternmakers are necessary to produce a job in half-a-day, which would normally take one man three or four days, there is, incidentally, an inspirited display of real co-ordination of effort, undoubtedly good for all concerned. Under such stress, latent powers are awakened. Within a few minutes, the interest of all concerned must be enlisted. Thinking must not only be speedy—it must be "sure-footed." The job is parcelled out according to the various capacities present (for all men are not equal in the pattern-shop), and a big problem is solved by cutting it up into smaller ones. Occasionally, however, one meets with a job that defies the solution of simple sectioning. Fig. 4 illustrates a pattern of this type. This was a "cast-same-day" job. With the exception of the top and bottom lugs, F, the pattern was made from one single piece of ¾-in. plywood. Instead, therefore, of having to segment-up the pattern—as normally—it was directly marked out on the plywood board. At this point there is another advantage to be gained by the use of our versatile ally. It is, of course, the business of the patternmaker not only to make his pattern according to blue print, but so to construct it that the moulder, with ordinary care, can produce the desired casting.

Here, Fig. 4, is a shape that is far too fragile to be left to itself. A metal pattern, admittedly, would serve, but a "master" pattern must first be created. In this case, it was immediately patent that some reliable reinforcement was necessary to prevent possible distor-

(*Concluded on page* 122.)

Alloys for Use at High Temperatures.

EFFECT OF COMPOSITION AND EXPOSURE TO HIGH TEMPERATURES.

By C. H. M. Jenkins, D.Sc., A.R.S.M., and H. J. Tapsell, A.C.G.I., A.M.I.Mech.E.

(Abridged.)

(Concluded from page 48.)

SECTION II.—EFFECT OF EXPOSURE TO HIGH TEMPERATURES ON CHILL-CAST ALLOYS.

Effect on the Brinell Hardness.

Prolonged Exposure at 800 deg. C.—The results of the tests on the exposure of materials for various periods at 800 deg. C. are shown graphically in Fig. 4.

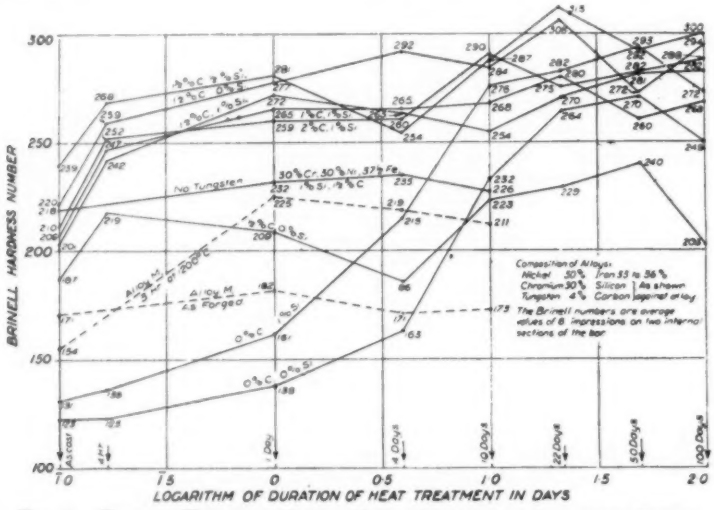
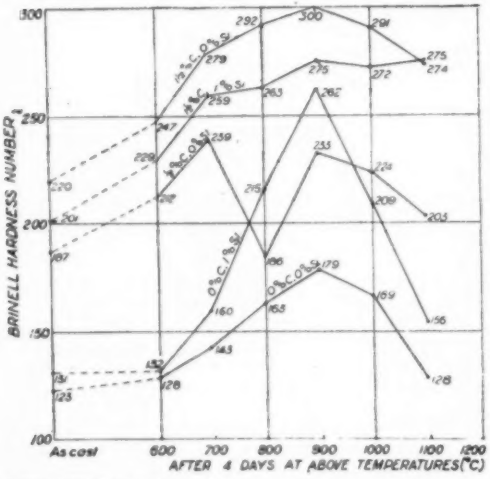

BRINELL HARDNESS NUMBER
LOGARITHM OF DURATION OF HEAT TREATMENT IN DAYS
As cast
1 Day
4 Days
10 Days
22 Days
50 Days
100 Days
No Tungsten
30% Cr 30% W. 37% Fe
Composition of Alloys:
Nickel 50% Iron 33 to 36%
Chromium 30% Silicon } As shown
Tungsten 4% Carbon } against alloy
The Brinell numbers are average values of 6 impressions on two internal sections of the bar

FIG. 4.—BRINELL HARDNESS (2-MM., 40-KG., 30 SECS.) OF ANNEALED NICKEL-CHROMIUM-IRON-TUNGSTEN ALLOYS CONTAINING SILICON AND CARBON.

The material selected for the series of tests consisted of chill-cast bars $1\frac{9}{16}$ in. dia. and approximately 4 in. in length. Confirmatory tests were carried out on material 1 in. dia. The Brinell hardness was measured on slices cut off both ends of the specimen, and the mean results have been recorded. The bars were then treated for 4 hrs. at 800 deg. C. and a slice, $\frac{1}{4}$ in. thick, was again cut off both ends of the bars. The hardness was therefore in all cases measured on freshly-cut surfaces of the bar. The subsequent tests were made by replacing the material in the furnace and continuing the heat-treatment for successive periods of time. The amount of oxidation, even after 100 days at 800 deg. C., was slight.



Composition of Alloys (per cent.):
Nickel 30; Chromium 30; Tungsten 4; Iron 33.5 to 36; Silicon and Carbon, as shown against alloy.

FIG. 6.—BRINELL HARDNESS (AVERAGE VALUES OF THREE IMPRESSIONS ON AN INTERNAL SECTION OF THE BAR) (2-MM., 40-KG., 30 SECS.) OF NICKEL-CHROMIUM-IRON-TUNGSTEN ALLOYS CONTAINING SILICON AND CARBON. (Specimens in cast condition annealed for 4 days at various temperatures.)

Considering the eight materials selected for examination, it appears that the carbonless alloys (C 0, Si 0; and C 0, Si 1) do not at once show an increase in hardness, but begin to change after 4 to 10 days. After 22 days they become as hard as the majority of the carbon-bearing alloys tested. The alloy C 0.5, Si 0 is anomalous, for it shows a slight hardening at the commencement, followed by a return to the original hardness. On further heat-treatment there is again an increase in hardness and a second fall.

The alloys containing 1 per cent. or more of carbon all show a marked rise in hardness even after an exposure of as short a period as 4 hrs. After a total exposure of 1 day the Brinell numbers of these alloys have increased by as much as 50. After this period of time the average hardness of the group of alloys rises slightly—perhaps 10 to 20 units—in the course of the following 99 days. Considering the alloys individually, there is a general tendency for a rise to occur at some period between 1 and 22 days, which is followed by a fall or a maintenance of a constant value for a short period. This is again followed by a recovery in the hardness value. The initial rise in hardness followed by a fall and a subsequent further rise after successive heat-treatments appears to be similar to the occurrences observed by various authors in the age-hardening, either at room temperature or accelerated at slightly higher temperatures, of certain aluminium alloys. These changes in hardness reflect the rapidity with which internal changes can proceed within the alloy. It is highly probable that the alloy which is likely to be most satisfactory in its resistance to creep at high temperatures will be that one in which the mobility of the atoms is most hampered at the service temperature, and the converse is probably equally true.

The poor resistance to creep of the alloy C 0.5, Si 0 appears to be related to the ease with which the various changes in the alloy can proceed towards softening at 800 deg. C. The alloy C 1.5, Si 1, on the other hand, shows a fairly characteristic steady course as a result of heat-treatment.

The noticeable difference in the mechanical behaviour of the carbonless and the carbon-bearing alloys is related to their markedly-different response to heat-treatment.

In Fig. 5 the Brinell hardness of the alloys is shown plotted according to composition. In these small diagrams lines have been drawn to indicate the course of the hardness curves for intervals of 20 Brinell units. The curves for the "as cast" condition are shown gradually to attain a higher value with increase of the carbon content. On treatment for either 4 hrs. or 1 day at 800 deg. C. the alloys show a general hardening, being numerically 20 to 40 points harder than previously. After this period of time the alloys containing 1.5 per cent. of carbon harden only slightly. The hardness of the carbonless alloys or of those of low-carbon content increases as a result of the 10-day exposure. Treatment for 50 days or more results in the carbonless alloys becoming slightly softer, and the alloy C 0.5, Si 0 is found to soften appreciably.

Exposure to Various Temperatures from 600 deg. to 1,100 deg. C.—In these tests, pieces of the same bars as were used in the prolonged exposure tests were heat-treated for a uniform period of 4 days at 600, 700, 800, 900, 1,000 and 1,100 deg. C.; in each of the six cases the pieces had not received any previous treatment. These tests emphasise the degree of stability of the five alloys tested, and confirm the observations which had been previously made. Without doubt a longer duration of exposure than 4 days would materially alter the order of the results; the maximum value obtained from the curves shown in Fig. 6 would possibly tend to occur at a lower temperature. The exposure at 900 deg. C. produces the hardest state in four out of the five alloys.

Considering the results recorded in Fig. 6, the alloy C 0, Si 0 shows a gradually increasing hardness after treatment at 700, 800 and 900 deg. C., whereas the alloy C 0, Si 1 shows a marked rise in hardness. Neither alloy is noticeably affected by treatment at 600 deg. C. At higher temperatures, as indicated by the tests at 1,000 deg. and 1,100 deg. C., softening sets in, and the fall in hardness corresponds with changes recorded in the examination of the microstructure. The alloy C 0.5, Si 0 shows hardening after treatment at 600 deg. or 700 deg. C. After exposure at 800 deg. C. the alloy is no harder than the cast material. Treatment at 900 deg. C., however, causes an increase in hardness, which is not maintained at higher temperatures (1,000 deg. and 1,100 deg. C.). It appears that this alloy follows the course of the carbon-bearing materials at low temperatures, but the carbon content is insufficient to prevent it from reverting to the behaviour of the carbonless alloys at higher temperatures.

The two alloys of high carbon content (C 1.5, Si 0 and C 1.5, Si 1) show a slight rise in hardness after treatment at 600 deg. C. and further rises in hardness until 900 deg. C. is reached. Above this temperature the alloy which does not contain silicon falls in hardness, whereas the alloy with 1 per cent. of silicon maintains a constant hardness of about 275, even after treatment at 1,100 deg. C. This alloy (C 1.5, Si 1; N.P.L. No. 183), once the maximum hardness has been attained, appears to suffer less change in hardness and in microstructure than any of the other materials tested.

In connection with these results it should, perhaps, be pointed out that similar Brinell hardness results, even in the same material after different temperatures of heat-treatment, do not

necessarily imply that a material possesses a similar resistance to creep at 800 deg. C. or at any other temperature of comparison.

The graphs shown in Fig. 7 embody the same results as those shown in Fig. 6, and are plotted on the basis of composition. They give the effect of various temperatures of exposure for a constant period of 4 days.

The curves show that for a constant time of treatment of 4 days at 600 deg. C. the carbon-bearing alloys alone show a rise in hardness. At 700 deg. C. a rise of 20 to 40 in hardness number has occurred throughout the series; a still further rise is noticed at 800 deg. C. In general, although the maximum values are produced by this treatment at 900 deg. C., only a slight fall occurs in the alloys at 1,000 deg. C., but after exposure at 1,100 deg. C. a very marked fall occurs, except in the alloys containing 1.5 per cent. of carbon. Probably the alloy which offers the best resistance to creep at any specified temperature may be the one whose enhanced Brinell hardness falls off most gradually with a further rise in the temperature of treatment.

The above results were determined on material cooled from the treatment temperature in air. Material quenched in water, and also slowly cooled in the furnace, was also examined. The hardening effects produced are similar to those obtained with air-cooled bars. Accelerated hardening by a shorter exposure at a higher temperature may not be strictly comparable with a longer exposure at a lower temperature. Thus, treatment for 4 days at 900 deg. C. was applied to three of the five alloys tested above so that their properties and behaviour at 800 deg. C. might be examined. This period of treatment, as far as the Brinell hardness of the material is concerned, is possibly equivalent to 20 to 50 days' treatment at 800 deg. C.

Mechanical Properties of Heat-Treated Material.

The three alloys which had been heat-treated at 900 deg. C. for a period of 4 days were then subjected to short-time and prolonged tensile tests. These tests would show how far the increase in strength as indicated by Brinell-hardness tests is reflected in the other properties. The results of the tests are contained in Table VI.

The heat-treated alloy C 0, Si 1 shows, in comparison with the untreated material, a slight fall in tensile strength at room temperature, and a marked fall in the corresponding elongation from 28 per cent. to 1.5 per cent. The strength under both short-time and prolonged tensile tests at 800 deg. C. is slightly improved.

The alloy C 0.5, Si 0 has a slightly-improved tensile strength at room temperature and a slightly-reduced strength at 800 deg. C. under both short-time and prolonged tensile tests.

The alloy C 1.5, Si 1, previously referred to as alloy No. 183, shows only a slight decrease in the short-time and prolonged tensile tests at 800 deg. C. as a result of exposure to 900 deg. C. for 4 days. The above results indicate that although there was a great increase in the Brinell hardness of the alloys after treatment for 4 days at 900 deg. C. (see Fig. 6), the properties as determined by either short-time or prolonged tensile tests were not greatly affected.

Impact tests were also made in an Izod testing machine on both B.E.S.A. standard 10-mm. by 10-mm. notched-bar test-pieces and on unnotched test-pieces. The energy to fracture resulting from a hammer-blow of 120 ft.-lbs. is as follows (ft.-lbs.):—Notched specimens (unnotched specimens)—C 1.5, Si 1, as cast, 1.5 (13.0), treated 4 days at 900 deg. C., 0.7 (4.0); C 0, Si 1, as cast, 76.1 (not determined), treated 4 days at 900 deg. C., 1.2 (6.2); C 0.5, Si 0, as cast, 1.1 (7.0), treated 4 days at 900 deg. C., 1.8 (14.0). The tests were carried out in such a way that the blow was delivered in the same position relative to the cast bar in both the notched and unnotched bars.

The above results correspond closely to the elongations reported for the tensile tests. In the case of alloy C 0, Si 1 the elongation was 28 per cent. in the cast state, and 1.5 per cent. in the heat-treated condition. The corresponding notched-bar values are 76.1 and 1.2 ft.-lbs.

Although the present work indicates that a considerable increase in Brinell hardness occurs as a result of exposure to high temperatures, subsequent mechanical tests have not shown that the tensile strengths of the alloys are markedly improved either at atmospheric temperature or at 800 deg. C. The changes in Brinell hardness at atmospheric temperature are in all cases dependent on phenomena that have occurred during the course of exposure to high temperatures. Although the material inside the crystals after exposure at high temperature is found to be harder at room temperature, it seems probable that the susceptibility to failure by intercrystalline separation under stress at high temperatures—the mechanism by which materials rupture at these temperatures—has not been greatly affected.

Correlation of the Effects of Exposure on the Microstructure and the Hardness of the Alloys.

Effect of Silicon.—On heat-treatment there is a marked separation of a second constituent on the cleavage planes of the crystals. On treatment at 800 deg. C. a considerable increase in the hardness occurs after 4 to 10 days, but that increase of hardness does not markedly affect the strength of the material as determined by tensile tests. The alloys are readily affected by heat-

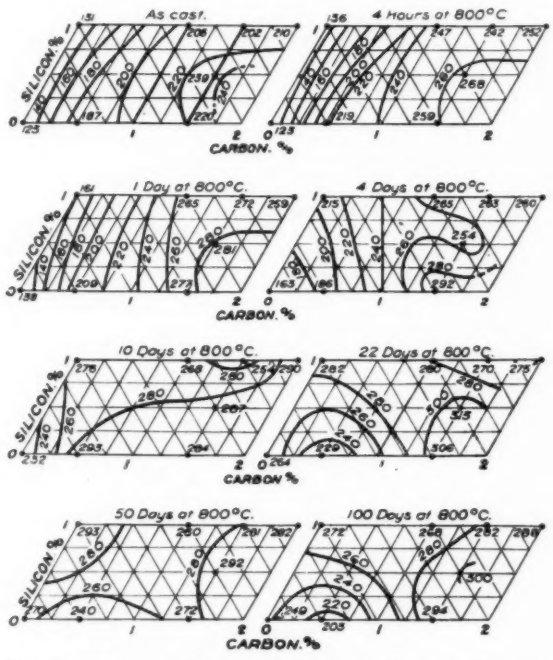


Fig. 5.—Effect of Heat-Treatment on Brinell Hardness of Chill-Cast Alloys. (For conditions of hardness tests and compositions of alloys, see Fig. 4.)

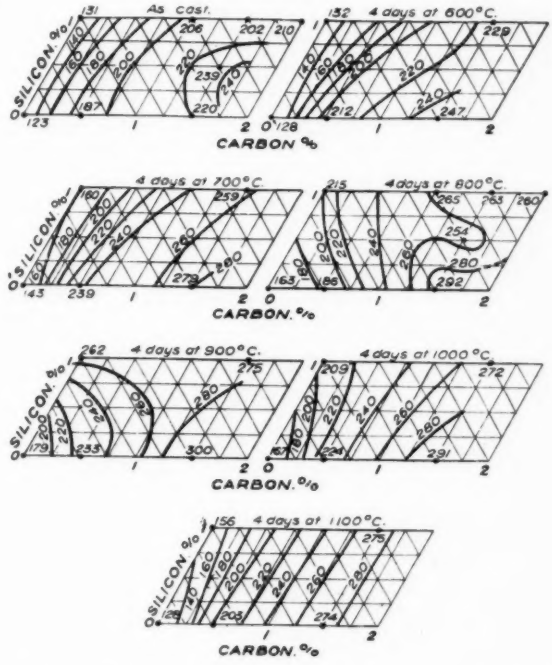


Fig. 7.—Effect of Heat-Treatment on the Brinell Hardness of Chill-Cast Alloys. (For conditions of hardness tests and composition of alloys, see Fig. 6.)

Effect of Carbon with and without Silicon Addition.—The presence of carbon causes the separating constituent, which is deposited from the solid solution, to form a shower of fine particles. The strength of these alloys is superior to those described in the previous paragraph. There appears to be a critical proportion of carbon (about 1.5 per cent.) which produces the most desirable hardening action.

SECTION III.—DISCUSSION ON THE CHANGES IN THE ALLOYS ON EXPOSURE.

From the account of the changes indicated in Section II, it appears that the hardening action, or at least a part of it, is related to the separation of a complex constituent, probably a carbide in the case of the carbon-bearing alloys, from the solid solution. Under the ordinary conditions of casting, the complex solid solution retains this constituent in solid solution. It is probable that the separation is not a simple one, and it is possible that the change may take place in one or perhaps two independent stages, such as, first, the visible separation of a constituent, and,

XUM

secondly, a further internal change which produces marked hardness changes but little visible structural change.

Ternary nickel-chromium-iron alloys of approximately the same composition as those in this series of alloys appear to be simple solid solutions at the temperatures under consideration. The addition of tungsten, however, has possibly a pronounced effect, especially if carbon and silicon are also added to alloys, and it was therefore desirable to investigate the effect of the absence of tungsten in an alloy otherwise similar to No. 183. Tests were made upon an alloy containing 1.5 per cent. of carbon, 1.0 per cent. of silicon, but without the customary addition of 4 per cent of tungsten. The results of the exposure tests set forth in Fig. 4 show very little hardening action as compared with the other alloys of the series. The absence of the tungsten has but a slight effect, if any, on the appearance of the constituents which solidify. The alloy contains a very small proportion of primary solid solution compared with the corresponding tungsten-bearing alloy. On heat-treatment, however, the separation of the second constituent occurs in the usual manner in that portion of the eutectic which has the same composition as the primary solid solution. The composition and the results of the short-time and of the prolonged tensile tests on the tungstenless alloy (No. 301) are given at the foot of Tables III and IV. The material is relatively weak compared with alloy No. 183.

In view of the importance of tungsten, the behaviour of a wrought tungsten-bearing alloy was investigated. In the forged state as supplied by the manufacturers this material does not exhibit any appreciable hardness changes as a result of exposure to 800 deg. C. for periods not exceeding 10 days. On the other hand, if the alloy is subjected to heat-treatment for 3 hrs. at 1,200 deg. C. to effect solution of a part of the carbides, it shows marked hardening on exposure to 800 deg. C. The results of these tests are shown in Fig 4. The microstructures of these materials were also investigated.

A somewhat similar heat-treatment was attempted on alloy No. 183 (C 1.5, Si 1). The results were as follow: (Brinell hardness) as cast 213; after 1 day at 120 deg. C. 199; after 7 days at 800 deg. C. 196. It appears that treatment of this alloy at 1,200 deg. C. for 1 day softens the material by aggregating the constituents, but does not bring about a re-solution of the carbides, which would be likely to increase the hardness on again exposing the material to 800 deg. C. It thus appears that on casting, the separation of the constituents is suppressed, but the action is not reversible even if the alloys are reheated to 1,200 deg. C. This alloy (No. 183) melts at a temperature slightly above 1,280 deg. C.

From the above results it appears that tungsten, although not visibly affecting the microstructure, has a pronounced effect on the Brinell hardness of the alloys.

Conclusions.

The effect of composition and the results of short and prolonged stress tests at 800 deg. C. were studied in relation to alloys containing: Nickel, 30; chromium, 30; tungsten, 4; iron+silicon+carbon, 36 per cent. The greatest resistance to prolonged stress occurs in the alloy containing 1.5 per cent. of carbon and 1 per cent. of silicon. This alloy, which has been previously referred to as N.P.L. alloy No. 183, melts between 1,285 deg. and 1,315 deg. C.

As a result of exposure to temperatures between 600 deg. and 1,100 deg. C., the alloys of this type undergo an increase in Brinell hardness and a change in microstructure. The phenomena encountered explain the improvement in the mechanical properties of the quarternary alloys containing nickel, chromium, tungsten and iron resulting from the addition of carbon and silicon. The most suitable alloys for stress resistance appear to be those which maintain, after the initial period, a fairly constant Brinell hardness after exposure to high temperatures.

In view of the high proportion of nickel and chromium, these alloys remain in the austenitic condition throughout the temperature range between their melting points and atmospheric temperature. No hardening action of the type described in the Paper can therefore be ascribed to the suppression of the transformation in iron. On the other hand, the addition of carbon to a ferritic steel is, in general, thought to cause a gradual but continuous increase in hardness. An alloy containing similar proportions of carbon, silicon, chromium and nickel, but no tungsten, exhibits changes in microstructure similar to those of an alloy containing 4 per cent. of tungsten, but there is no appreciable increase in hardness on the heat-treatment of tungsten-free alloys, whereas on heat-treatment the tungsten-bearing alloys exhibit an increased hardness. The strength of the tungsten-free alloy under prolonged tensile tests is low.

The phenomena encountered in the present experiments, although rendered obscure owing to the number of metallic or other elements present at one time, bear in several of their aspects some resemblance to the changes often referred to as "age-hardening" in the alloys of aluminium—for instance, duralumin. In such age-hardening it is found that the hardness changes are practically complete before visible separation of new constituents is detectable under the microscopic. In the present instance the hardness changes appear to occur contemporaneously with the separation of a new constituent, but it is probable that hardness changes due to other phase separations may occur and not be accompanied by a visible structural change.

On the other hand, Masing observes that in copper alloys containing 3 per cent. of beryllium visible changes in microstructure occur contemporaneously with hardness changes. Corson similarly shows, in regard to copper alloys containing small proportions of nickel silicide, chromium silicide, etc., a phase separation at the same time as hardness changes are occurring. In this case the compounds are retained in solution at high temperatures and rejected at lower.

In the present instance the extent and speed of the observed changes differ widely in the various alloys examined. On account of the gradual changes which produce hardening, these materials retain their high initial strength for long periods at 800 deg. C. The somewhat narrow range of composition in which the most favourable properties occur appears to be associated with the separation of a special compound or phase.

These phenomena, accompanying creep as indicated in the present Paper, are possibly of wider application to other series of alloys. The tendency of a material to harden at the service temperature is probably accelerated by deformation such as is likely to occur in an alloy subjected to high stress in service. The resulting internal movement in the alloy will probably hasten the changes in the material which lead to the hardening action.

The Paper also gives details of microscopic study and includes a selection of micrographs.

Table VI.—*Mechanical Properties of Complex Nickel-Chromium-Iron Alloys. Results of Tests on 1-in. dia. Chill-Cast Bars after Heat-Treatment for 4 Days at 900 deg. C.*

Alloy no.	Condition tested.	Short-time tensile tests. At air temperature. Ultimate stress. Tons per sq. in.	Short-time tensile tests. At air temperature. Elongation. Per cent.	Short-time tensile tests. At 800 deg. C. Ultimate stress. Tons per sq. in.	Short-time tensile tests. At 800 deg. C. Elongation. Per cent.	Prolonged stress tests at 800 deg. C. Life in days before rupture occurs. 8 Tons per sq. in.	4 Tons per sq. in.	3 Tons per sq. in.
264	As cast	28.7	28.0	12.4	3.0	1 hour	< 1 day	2–5
	Heat-treated ..	25.0	1.5	15.4	1.5	—	19.5 hours	5
137	As cast	31.0	2.0	20.1	3.5	—	12.5 Flaw	—
	Heat-treated ..	33 5	1.0	16.5 Flaw	3.0	—	6	—
183	As cast	48.4	2.0	30.6	4.5	15½	—	309*
	Heat-treated ..	43.5	1.5	27.4	3.5	13	—	—

* Unbroken; extension, 1 per cent.

Plywood in the Patternshop.

(*Concluded from page* 119.)

tion. Happy thought—why not make use of the redundant material left after shaping the job? This, thanks to plywood, solved the problem. Instead of cutting out the pattern to the shape of the required casting, some of the material was left *in situ*, G, Fig. 4, to serve as a reinforcement. In this way, a very rigid pattern was obtained. No especial care was needed in ramming up the job in the foundry, and the stopping-off pieces acted as rapping-plate blocks. Stopping-off these was but the matter of a few moments. Finally, the casting was made "same day."

How another fragile form was successfully dealt with through the agency of plywood is shown in Fig. 5. The pattern, generally, contains several interesting features. It is seen to present difficulties both in plan and elevation. Its peculiar plan shape is complicated by its three distinct planes. In marking out the plywood base, one had to consider the need for reinforcement of the arm, H. This support was secured by leaving unsevered the material connected with the end of the arm, J. The supporting plate was further stiffened up by the addition of a deep, stopping-off strip, K, which, in turn, was built into the main core print at L. The strip, K, by the way, needs no stopping-off attention on the part of the moulder. The core, M, automatically stops out one end of the strip and the broad end of the plate, then the stopping-off of the plate at the neck, J, closes up the other end of the strip impression in the mould. The raised quadrant arm, N, was built on the block core-print, M. This pattern proved to be rigid, unshrinkable and durable.

From the foregoing, it will be gathered that plywood is a very real asset in the patternshop. It is in the lighter classes of work, of course, that it will be found most serviceable. And although the patternmaker might naturally be expected to be somewhat averse to its employment (being a new product), once its advantages are realised, it is a case of "the appetite grows by what it feeds upon," and whenever the fragile, "wanted-to-day" job comes along he will seek salvation in the new material with the question: "What about plywood?"

Six young South Africans have been selected by the directors of the South African Iron & Steel Industrial Corporation, Limited, to be sent oversea to study methods of iron and steel production in England and Germany, and possibly in Sweden. On their return they will be employed at the Pretoria Steelworks.

The Outlook for Copper.

By "Onlooker."

The publication of the July statistics for copper came as a further unpleasant reminder of the parlous state into which the red metal has fallen, for the combined accumulation of blister and refined copper amounts to some 620,000 short tons compared with 560,000 tons a year ago, this increase having come about through a reduction of 60,000 short tons in rough-copper reserves and an increase of 120,000 short tons in the stocks of refined. It is indeed a sorry state of affairs when the total deliveries, export and domestic, amount to only 69,000 short tons in one month, for this is below the average for U.S.A. alone in a normal period. These figures do not, of course, give a world picture of what is going on in copper, for there is African and European production of close on 200,000 tons to be reckoned with, the only consolation being that stocks do not seem to be increasing to any extent in the Old World.

If the situation is to be put right, it would seem that drastic curtailment of output must be instituted, and that it is time a truce were called to talking and action taken speedily. The present rate of production is well below what it was, and has actually been reduced by nearly 20 per cent., but consumption has contracted by at least 40 per cent. and shows no signs of improving, in spite of a record low price. Stocks in consumers' hands are admittedly low, and there is not yet sufficient confidence in the future of the metal to persuade buyers to purchase with any degree of freedom, so that a hand-to-mouth policy is obviously indicated. In brief, the producers, having elected to trade direct with users, have been left to "carry the baby" with a vengeance, and the experience must be costing them a pretty penny!

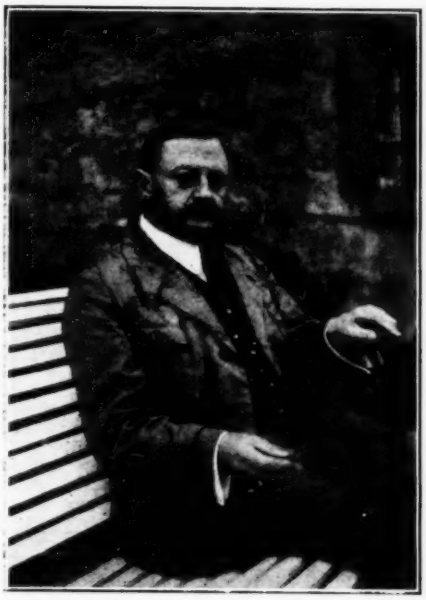
At the time of writing, copper in New York stands at somewhere around 7¾ cents, with the exporters quoting 8 cents c.i.f. European ports, but since the indications are in favour of a lower level, something different may well be ruling by the time of publication. Standard copper has been down to a new low record, the three months' quotation narrowly missing a fall below £33 per ton, while the official wire-bar price is listed just now at £37 2s. 6d. It is doubtful if anyone was clever enough six months ago to foresee such undreamt of levels. Yet all discussions on the subject of curtailment have come to nought and it looks as if agreement on this admittedly difficult problem is as far off as ever. So many interests are involved that it is a question whether the solution will ever be reached by discussion and arrangement, and it is quite possible that all negotiations will be abandoned and the issue resolved by a straight fight to a finish between the high cost and low cost interests.

Under the present arrangement of quotas, the producers who can still see a bare profit even at the present ruinous price are suffering the mortification of seeing stocks heaping up on their hands, and what is more important this process has been going on for months and months, during periods when the price was considerably higher than it is to-day. In other words, sales could have been made on a much more profitable basis had it not been for this scheme of quotas, which has a decidedly deadening effect on enterprise. It is, of course, an open secret that there has been considerable disagreement in the ranks of the Export Association, and the cheap producers have been making their voices heard pretty loudly of late, their contention being—and it is difficult to pick holes in it—that those who find the ruling level unproductive ought to get out.

It is, of course, more than likely that the subject of curtailment has not been very favourably received in political circles in the States, for cutting down output means increasing unemployment and of that particular bogey there is already too much across the Atlantic. In suffering from a low price, copper is in line with practically all other commodities, but, whereas in the case of lead, tin and spelter, drastic steps have been taken to overcome the difficulty by cutting down output, nothing adequate to the need has yet been achieved by the copper interests. So gloomy, however, is the statistical picture and so low the price of the metal that either by arrangement or from sheer economic necessity inroads upon the rate of mine output will probably shortly be made. If this prove to be of a substantial nature the quotation is certain to respond and some gain will be registered.

The New President of the V.D.E.

As previously announced in The Foundry Trade Journal, the Verein Deutscher Eisengiesserien (the German Ironfoundry Employers' Federation) has elected Baron Wittgenstein as President in the place of Dr. S. G. Werner, who occupied that position for close on two decades.



Baron Wittgenstein
(The New President of the V.D.E.).

Friedrich Carl, Baron Wittgenstein, was born on April 29, 1887, at Carlsburg, near Laasphe, in Westphalia. He received his early education at the Realgymnasium at Siegen, whilst later he studied at Göttingen, Berlin and Marburg. When, at the end of 1914, his elder brother was killed in the war, he was called back to the family business—the Eisenwerk Friedrichshütte, a concern with which the name of Wittgenstein has been connected for more than 100 years. Besides being the President of the German Ironfoundry Employers' Federation, he is also the chairman of auxiliary organisations which have to do with the marketing of castings, centred in Kassel, and wages. He takes a deep interest in industrial educational matters and is an honorary member of many important committees.

Tenders for Government Contracts in Morocco.—The Department of Overseas Trade (35, Old Queen Street, London, S.W.1) has issued a memorandum on the General Conditions governing Tenders for Government Contracts in Morocco, prepared by the British Consular Officers at Rabat, Tangier and Tetuan. (Reference No. C. 3605.)

British Works Management Association.

The first annual conference of the British Works Management Association will be held at the Hotel Metropole, Northumberland Avenue, London, W.C.2, on Friday, October 2. The subject to be dealt with at the morning session is "Works Management in Relation to Rationalisation." Mr. G. Hurford, M.I.E.E., director of manufacture, Standard Telephones & Cables, Limited, and chairman of the council of the British Works Management Association, will take the chair, and the speaker will be Mr. Frank Hodges, J.P., of the Central Electricity Board. At the luncheon the chairman will be Mr. E. J. Fox, managing director of the Stanton Ironworks Company, Limited, and President of the British Works Management Association. The guest of honour will be Mr. Robert R. Hyde, director of the Industrial Welfare Society, and the subject for consideration "Works Managers and Labour Problems."

"Factors in Successful Mechanisation" is the subject for the afternoon session. The chair will be taken by Mr. A. P. Young, O.B.E., M.I.E.E., manager, Rugby Works, British Thomson-Houston Company, Limited, and Vice-Chairman of the British Works Management Association, and the provisional speaker is Mr. G. E. Rowland, chairman of Agricultural & General Engineers, Limited.

Tickets, inclusive of both sessions of the conference and of luncheon and tea, but not of wines, are £1 1s. each, and may be obtained by making application accompanied by remittance to Mr. Clifton Reynolds, joint hon. secretary, British Works Management Association, 68, Victoria Street, London, S.W.1.

Book Review.

The Chemists' Year Book, 1931. Edited by F. W. Atack. Published by Sherratt & Hughes, 34, Cross Street, Manchester. Price 21s. net.

The particular advantage of this book to the foundry chemist is shown when his work happens to take him off the beaten track. Obviously, he should have at his finger-ends all the factors associated with the routine analysis of the metals and alloys he handles. If, however, he is called upon to analyse fuels, refractories, paints, oils, fats and greases, then he will find this book especially useful. Sometimes he will be disappointed; for instance, if he has to convert a quantity of Continental mechanical tests to tons per sq. in., he will find on page 1185 a table of use to Continentals handling American test results, but, normally, useless to the Britisher at home. Looked at from the foundry chemist's point of view, this mild criticism is of minor importance, because in actual practice he would not resort to a chemists' handbook for mechanical data; and if such matter were deleted it would not detract from the value of the book as a work of reference. In fact, our advice to the editor is to omit any tables of an engineering character, as these are easily obtained elsewhere. We have carefully examined the sections likely to be consulted by foundry chemists and can thoroughly recommend the acquisition of this handbook as being of extreme utility in what may be called an "emergency" from their point of view. The book contains well over a thousand pages, and is reasonably well indexed. The offer of the editor to help in case of essential data being untraceable is praiseworthy.

Messrs. Swan, Hunter & Wigham Richardson, Limited, Wallsend, have laid the keel of a new passenger ship for French owners, the order for which was secured a week or two ago.

Trade Talk.

No foreign iron ore was imported at the Prince of Wales Dock, Workington, in July.

The New Zealand Shipping Company's 9,018-ton steamer "Ruapehu" has been sold to Italian shipbreakers.

Scott & Sons, Bowling, have received from J. Fisher & Sons, Limited, an order for two coasting steamers. Aitchison, Blair, Limited, Clydebank, will supply the propelling machinery.

Dorman, Long & Company, Limited, Middlesbrough, are closing down the blast furnaces of their Redcar plant on account of accumulation of pig-iron stocks. Some 400 men will be affected.

Mr. George H. Foston, until recently managing director of Lander & Larsson, Limited, has commenced business on his own account at 2, Exchange Buildings, Birmingham, as pig-iron, iron-ore, coke and metal merchant.

A new company has been formed to carry on, under one management, the business of marine engineers and shipbuilders undertaken by the former firms of M'Kie & Baxter, Limited, Govan, and Campbell & Calderwood, Limited, Paisley.

Harland & Wolff, Limited, Govan, Glasgow, have received an order to build a pontoon, 150 ft. long and 50 ft. wide, for a floating crane which will be used in South African harbours. They will also supply twin-screw triple-expansion engines.

Recent orders placed by the U.S.S.R. in Great Britain include one received by John Lang & Sons, Limited, Johnstone, for tools and machinery. The total value of the order has not yet been definitely ascertained, as it comprises a wide range of goods. The firm has carried out work for Russia for many years.

The United German Steelworks is reported to have secured an order from the South African railways for 6,250 tons of steel sleepers. It is stated that this is part of total orders for 9,250 tons of sleepers which the South African railways have placed on the Continent. British steelworks were unsuccessful tenderers.

David Rowan & Company, Limited, Glasgow, have secured the contract to supply propelling machinery for the two vessels which Lithgows, Limited, will build for J. & C. Harrison, Limited, London. This will consist of triple-expansion engines, steam being supplied by boilers working at a pressure of 220 lbs. per sq. in.

The 22,600-ton whaling vessel "Svend Foyn," built at the Furness Shipbuilding Yard, Haverton Hill-on-Tees, made her trial trip on August 10. The "Svend Foyn" and her sister ship, the "Vestfold," are the largest vessels to be built on the Tees. Messrs. Richardsons, Westgarth & Company, Limited, of Hartlepool, supplied the engines.

The French Société Anonyme Hauts Fourneaux de Pont-à-Mousson are in negotiation with the Japan Steel Tube Company in the matter of erecting a foundry in Japan for producing pipes by the centrifugal process. The output contemplated is 25,000 tons per annum. Hitherto Japan has imported pipes of 6 in. and over, chiefly from France, Germany and the United States.

A strike of 80 moulders employed at the Acklam Foundry of Messrs. James & Ronald Ritchie, Limited, Middlesbrough, has resulted in 100 other employees of the firm being laid idle. The firm recently agreed to a revised basis of wages for certain sizes of pipes, but the moulders asked for a revision for other sizes, and to this the firm was unable to agree.

Messrs. Riley Bros. (Boiler Makers), Limited, who closed down their Perseverance Boiler Works at Stockton about two months ago through the severe trade depression and restarted part of their plant some few weeks later to execute minor orders which had come to hand, have just booked a contract for four boilers of their patent vertical water-tube type for the French Navy.

The Suffolk Iron Foundry (1920), Limited, of Stowmarket, have placed an order with J. W. Jackman & Company, Limited, Manchester, for sand-distribution and mould-conveying equipment, including elevator and conveyors. It will be remembered that in 1921 the design of this foundry won the 1st Prize of thirty guineas which we then offered for an article on the lay-out of a modern jobbing foundry.

A circular to the shareholders of the Duffield Iron Corporation, Limited, states that, in view of the imminence of an early completion of the special work which has been proceeding since the last report to the shareholders, and the expectation of being in a position to place before them a development policy based on the result of such work, the directors have decided to hold the annual general meeting in September.

The Standing Committee appointed by the Board of Trade will hold an inquiry at 11.30 a.m. on October 12, and at 10.30 a.m. on October 13 (if necessary), as to whether imported iron or steel flush pipes, whether galvanised or not, should be required to bear an indication of origin. The inquiry will be held at the Board of Trade Offices, Great George Street, London, S.W.1. Communications should be addressed to the secretary, Mr. E. W. Reardon, at that address.

Messrs. Vickers-Armstrongs, Limited, have received an order from the Great Western Railway Company for the supply of two pairs of steel lock gates for the inner lock of Roath Dock, Cardiff, also for the hydraulic operating machinery for the gates. The new gates will be constructed at Barrow, and the hydraulic machinery at Elswick, Newcastle-upon-Tyne. The firm has also secured orders from the Blue Star Line for extensive reconditioning of the two 10,000-ton liners "Afric Star" and "Stuart Star." The work will occupy a considerable time, and will cost about £40,000.

Personal.

Mr. Granville Pollitt, of Horwich, sailed from Liverpool last Friday for St. John's, Newfoundland, where he is to start up a brass-foundry department for a local iron foundry. He took with him both melting plant and raw materials.

Mr. S. E. Dawson has joined the staff of Sir W. G. Armstrong, Whitworth & Company (Iron-founders), Limited, Close Works, Gateshead, as foundry metallurgist. He is to initiate a research investigation on rotary-furnace irons.

Prof. H. F. Moore, of the University of Illinois, is now on a visit to this country, where he will inspect the National Physical Laboratory. In September he will attend the congress, held in Zürich, of the New International Association for Testing Materials.

Mr. J. Callander has been appointed general manager of all departments of the naval construction works at Barrow of Messrs. Vickers-Armstrongs, Limited, responsible to the managing director, Commander C. W. Craven, R.N. Mr. W. H. Johnson has been appointed works manager of all engineering departments at Barrow. Mr. G. W. Barr has resigned his position as director in charge of the shipbuilding department.

Mr. Thomas Mowat, who has just completed 50 years' service with Harpers, Limited, Craiginches, Aberdeen, has been presented with gifts from the directors and staff and from the Harper family. Mr. Mowat started in the patternshop of the old Albion Iron Works on August 11, 1881, and on completing his apprenticeship worked successively as journeyman and foreman patternmaker. He was appointed overseer when the new works were built at Craiginches, and was closely associated with the late Mr. John Harper, jun., in the erection, equipment and organisation of these works. Shortly after the new works were opened he was made works manager, and since 1912 has been managing director. He is a member of the Institution of Mechanical Engineers, Chairman of the Engineering and Allied Employers' Aberdeen and District Association, and has been President of the Aberdeen Mechanical Society.

Wills.

Hunt, C. H., a director of Daniel Doncaster & Sons, Limited, Sheffield, steelmakers	£21,209
Booth, W. J., director of J. Booth & Son, Limited, milling engineers, Congleton	£12,537
Thom, F., lately a director of Yates & Thom, Limited, engineers and iron-founders, Blackburn	£99,363
Perry, J. E., founder and a director of John E. Perry & Son, Limited, metal merchants, Wolverhampton	£13,560

Iron Roads.

On Tuesday, a new type of road incorporating the use of cast iron was officially opened. It is a portion of the Romford Road at Stratford, in the East End of London. Mr. Frank Hough, the chairman of Iron Roads, Limited, drove his car over the stretch, making every effort to skid, but found it impossible to do so.

Obituary.

Mr. R. C. Clinker, who for many years had been associated with the British Thomson-Houston Company, Limited, Rugby, has died as the result of an accident while on a mountaineering holiday in North Wales. When the B.T.H. Company was formed in 1896, Mr. Clinker was one of the first members of the technical staff, having the previous year joined the Bankside Works, which then became part of the B.T.H. organisation. He spent some time in research on the magnetic ageing of iron with Dr. Parshall and Mr. H. M. Hobart, and when Mr. Hobart left the company the Technical Department which he had organised was left in charge of Mr. Clinker. Later, Mr. Clinker took control of transformer engineering. In May, 1920, he joined the staff of B.T.H. consulting engineers, and when the Engineering Laboratory was formed in 1924 he was appointed its chief. He resigned this position in January, 1929, and since then, as Research Engineer, had devoted his attention to research work over a wide range of subjects.

The British Cast Iron Research Association.

(*Concluded from page* 112.)

Publications Committee.

The supervision of the Library and Information Bureau and the circulation of reports to members, etc., is supervised by the Publications Committee, which is comprised of those members of Council whose names are prefaced by **P** in the first list, together with the following co-opted members:—

Mr. N. E. P. Harris (Bullers, Limited, Tipton).
Mr. T. M. Herbert, M.A. (London Midland & Scottish Railway Company, London).

The Chairman is Mr. W. B. Parker, F.I.C., of the British Thomson-Houston Company, Limited, Rugby.

Education Committee.

The remaining main committee of the Council, apart from the Scottish Committee which will be referred to later, is the Education Committee, which deals with training of Members' apprentices and others, and co-operates with the Institute of British Foundrymen and other bodies on education and training in the industry. It consists of those gentlemen in the above list whose names are prefaced by **E**, together with the following members:—

Mr. S. A. Gimson (Leicester).
Mr. J. M. Primrose (Grangemouth Iron Company, Falkirk).
Mr. John Shaw (Brightside Foundry & Engineering Company, Limited, Sheffield).

The Chairman of the Committee is Mr. E. R. Briggs, M.Inst.C.E., English Electric Company, Limited, Rugby.

The Committee arrangements provide for a very closely-knit organisation. The Chairman of Council is an *ex-officio* member of all the committees and sub-committees. The Chairman of each main committee is a member of Council and a member of the other main committees. The main committees, where necessary, have sub-committees on which those of specialised knowledge and experience are co-opted, but the Chairman of each sub-committee is a member of the parent committee. Documents prepared for and circulated to a sub-committee are, after approval, circulated for the information of the main committee and similarly documents prepared for a main committee are, after approval, circulated for the information of the Council. The ultimate responsibility of the Council is, therefore, carefully maintained.

Ford's New Activities at Cork.

According to the Press, the Ford tractor factory at Cork is to enter into the competitive market for castings. This does not necessarily mean that they intend making castings for the automobile trade, but rather will they make the type of castings now being imported in large quantities by builders' merchants from Continental sources.

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Head Office: 37, RENFIELD STREET, GLASGOW:
Works: HALLSIDE, NEWTON and BLOCHAIRN, GLASGOW.

CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.

Established 1872. *Telegraphic Address: "Steel, Glasgow."*

ESTABLISHED OVER 110 YEARS.

MARTHA SIMM & SONS LTD.,

Nuns Lane Mills, GATESHEAD-on-TYNE

Manufacturers of

IRONFOUNDERS' BLACKINGS

DURHAM COAL DUST, CHARCOAL, &C.

IMPORTERS OF

FINEST CEYLON PLUMBAGO

ENQUIRIES SOLICITED

Telegraphic Address: "BLACKINGS GATESHEAD."
Telephone No.: 740 GATESHEAD.

Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—This week is the recognised holiday period on Tees-side, and very little business is passing. The buying power of the consuming trades is very limited. Cleveland ironmasters are meeting with severe competition from pig-iron makers in other areas who are endeavouring to get rid of growing stocks. The problem of unsold iron is becoming very difficult, and Messrs. Dorman, Long & Company, Limited, have decided, as a temporary expedient only, to damp down all but two of their blast furnaces this week, thus concentrating the total output. The ironmasters have made no alteration in prices, which remain as follow:—No. 1 Cleveland foundry iron, 61s. per ton; No. 3 Cleveland G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; and No. 4 forge, 57s. per ton.

In the East Coast hematite market the demand is very limited, as consumers will only buy to satisfy their immediate needs, in the hope of a further fall in prices. Some cargoes are being sold for shipment abroad, chiefly to Denmark, but at a very small margin of profit. The nominal price of East Coast mixed numbers is still 61s. per ton, but 60s. would not be refused by some makers if a substantial order were offered. On the North-West Coast there is much complaint of increasing competition from Cleveland makers, and the make may have to be curtailed. The price of Bessemer mixed numbers is still maintained at 66s. per ton at works.

LANCASHIRE.—There are few new orders passing, and short time operations are the general rule. The bad position of the textile machinery manufacturers is reflected in the poor demand by the foundries, in consequence of which unsold stocks of iron are reaching uncomfortably large dimensions. Prices remain unaltered. For delivery to users in the Manchester price zone, Staffordshire, Derbyshire and North-East Coast brands of No. 3 iron are on offer at 67s. per ton, with Northamptonshire foundry iron at 65s. 6d., Derbyshire forge at 62s., Scottish No. 3 at 87s. to 87s. 6d., and West Coast hematite iron at about 80s. 6d. per ton.

MIDLANDS.—The furnaces have been a little busier this week, fulfilling a number of small orders. Few new contracts have been placed. Consumers are not satisfied that a further fall in prices will not take place, and are only buying to cover immediate requirements. For delivery to Birmingham and Black Country stations the furnaces still quote 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, North Staffordshire and Lincolnshire No. 3.

SCOTLAND.—The demand is very poor, and with only one blast furnace blowing in the country deliveries are mostly being made from stock. Scottish ironfounders still quote as a minimum price 71s. per ton for No. 3 foundry, f.o.t. furnaces, with a minimum of 2s. 6d. per ton extra for No. 1. The price of Continental No. 3 remains at about 53s., f.o.t. Grangemouth.

Finished Iron.

The market is still very weak, and the future unpromising, although it is anticipated that there will shortly be an improvement in the demand for marked bars for railway work. Meanwhile, all the mills are only working part-time. Competition is keen for orders for Staffordshire crown iron, which is offered between the limits of £9 5s. and £10. Nut and bolt iron is at about £8 7s. 6d. Staffordshire marked bars are still at £12 at works.

Steel.

The finished-steel market is very depressed, and the makers have little work in hand. However, several orders for new ships have been announced, and it is hoped that a recovery is at hand. The market for semis is still lifeless, in spite of cheap offers by Continental works. It is noted that the Continental Wire Rod Syndicate has recently reduced export prices by about 5s. per ton.

Scrap.

The Cleveland market is in a state of almost complete stagnation, and no business has apparently been done for the last week or two. Ordinary heavy cast iron is nominally quoted at 40s. per ton, and good machinery scrap at 42s. The Midlands market is also lifeless, heavy machinery scrap being quoted at 47s. 6d. per ton, delivered, and light cast-iron at 37s. 6d. The market in South Wales remains inactive, and prices are only nominal. The Scottish market is also quiet, heavy machinery scrap, in sizes suitable for foundries, being quoted at about 47s. 6d. per ton, and ordinary cast-iron scrap at 42s. 6d. per ton.

Metals.

Copper.—It is difficult to derive any satisfaction from the recently published American statistics, which are the worst seen for some considerable time. It now seems evident that the American producers are incapable of effectual co-operation to curtail further the output to any substantial extent. The market, however, was prepared for unsatisfactory statistics, and prices were not unfavourably affected. Rumours of an improvement in the present financial position have helped to give the market more confidence, despite the existence of the huge copper stocks and the probability that they will further increase this month.

Closing quotations:—

Cash.—Thursday, £32 11s. 3d. to £32 12s. 6d.; Friday, £32 15s. to £32 17s. 6d.; Monday, £32 18s. 9d. to £33; Tuesday, £32 8s. 9d. to £32 10s.; Wednesday, £32 8s. 9d. to £32 10s.

Three Months.—Thursday, £33 10s. to £33 12s. 6d.; Friday, £33 13s. 9d. to £33 16s. 3d.; Monday, £33 17s. 6d. to £33 18s. 9d.; Tuesday, £33 6s. 3d. to £33 7s. 6d.; Wednesday, £33 6s. 3d. to £33 7s. 6d.

Tin.—The market has been weaker in the past few days, owing to the fact that there are unwieldy accumulations of stocks, which the declining tare demand is not likely to absorb. It is, of course, to be expected that the restriction scheme will shortly begin to have some influence upon the position, but it is unlikely that any great inroads will be made into the present stocks for some time.

Official closing prices:—

Cash.—Thursday, £115 17s. 6d. to £116 2s. 6d. Friday, £116 to £116 5s.; Monday, £115 10s. to £115 12s. 6d.; Tuesday, £114 7s. 6d. to £114 10s. Wednesday, £113 17s. 6d. to £114.

Three Months.—Thursday, £115 17s. 6d. to £116 2s. 6d.; Friday, £118 10s. to £118 15s. Monday, £118 to £118 2s. 6d.; Tuesday, £116 15s to £117; Wednesday, £116 5s. to £116 17s. 6d.

Spelter.—The statistical position is undoubtedly better. The agreement for curtailment of output, which came into force at the beginning of this month, has strengthened the market. The galvanising industries, however, are still finding trade very limited, and consumption generally is not showing any signs of improvement.

Daily fluctuations:—

Ordinary.—Thursday, £11 5s.; Friday, £11 3s. 9d.; Monday, £11 1s. 3d.; Tuesday, £11; Wednesday, £11 7s. 6d.

Lead.—The lead market is rather lifeless. The demand is limited, orders being only for small quantities to cover pressing requirements. The outlook of the market is not encouraging.

The week's prices have been:—

Soft Foreign (Prompt).—Thursday, £11 15s.; Friday, £11 12s. 6d.; Monday, £11 7s. 6d.; Tuesday, £11 10s.; Wednesday, £11 12s. 6d.

Correspondence.

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

B.C.I.R.A. Activities.

To the Editor of The Foundry Trade Journal.

Sir,—I must confess myself astonished at the letter under the above heading in last week's issue. The writer appears to me to be asking a research association to do the work that any foundryman ought to be able to do himself. In addition, to ask anyone to reduce costs of manufacture by a few pence per pound, would demand more than the Cast Iron Research Association are capable of, as the writer has no knowledge of castings of any kind that are sold at much above that price with the majority at about one penny. Most foundrymen would be delighted if they could reduce the costs a few pence per hundredweight. The Research Association has in the past and will still assist in many ways towards the attainment of that object.—Yours, etc.,

For Grangemouth Iron Company,
Jas. M. Primrose,
General Manager.

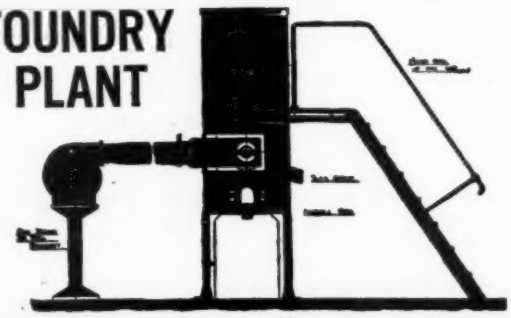
Grangemouth Iron Company,
Grange Iron Works,
Falkirk.
August 17, 1931.

Ground patternmakers' glue requires soaking for 20 mins., flake glue for 12 hrs., and thick cake glue 24 hrs.

JOHN HALL & CO.,
OF STOURBRIDGE, LIMITED,
STOURBRIDGE, ENGLAND.

Manufacturers of
FIRE BRICKS,
BLAST FURNACE BRICKS
& CUPOLA BRICKS.

FOUNDRY PLANT



E. ROPER & CO. North St.,
TELEPHONE: 596. TELEGRAMS: "CLIMAX." KEIGHLEY.

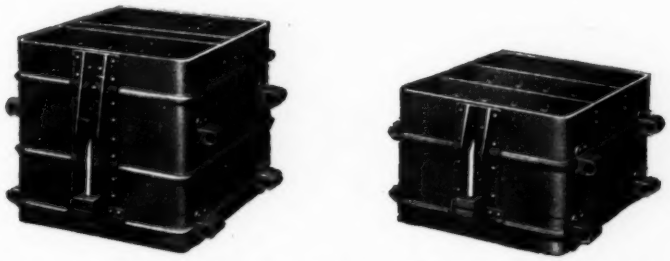
Sterling

MOULDING BOXES

WILL MAKE ENORMOUS SAVINGS WHERE CASTINGS ARE PRODUCED IN LARGE QUANTITIES.

They are ideal for all classes of moulding machines. They possess all the essential qualities necessary for rapid handling —Lightness; Rigidity; Durability; Permanent Accuracy; Freedom from Distortion and Freedom from Breakage.

All Sterling Boxes are made to specification and to suit the individual needs of each foundry. They are designed for use with either fixed or loose pins and we will drill them to suit your existing pattern plates.



STERLING BOXES FOR THE 12-TON STANDARD RAILWAY WAGON AXLE-BOX CASTINGS. WE HAVE MADE VERY LARGE QUANTITIES OF BOXES SIMILAR TO THE ABOVE FOR THIS PURPOSE.

We have a comprehensive range of standard styles of boxes covering every foundry service. Send your next moulding box enquiry to the leading moulding box manufacturers:—

STERLING FOUNDRY SPECIALTIES LTD.

London Office:
13, VICTORIA STREET, S.W.1

BEDFORD.

Telephone: 3345 BEDFORD.
Telegrams: "STERFLASK, BEDFORD."
Code: WESTERN UNION.

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	32	8	9
Three months	33	6	3
Electrolytic	35	10	0
Tough	33	0	0
Best selected	33	10	0
Sheets	64	0	0
India	44	15	0
Wire bars	37	2	6
Do., September	37	2	6
Do., October	37	2	6
Ingot bars	37	2	6
H.C. wire rods	38	0	0
Off. av. cash, Jul	34	9	1 1/16
Do., 3 mths., July	35	3	7 3/16
Do., Sttlmnt., July	34	9	2 15/16
Do., Electro, July	37	19	4 3/16
Do., B.S., July	36	5	10
Do., wire bars, July	38	12	9 3/16
Solid drawn tubes			10d.
Brazed tubes			10d.
Wire			6½d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	7½d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7½d.
Wire	7½d.
Rolled metal	6½d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN.

	£	s.	d.
Standard cash	113	17	6
Three months	116	5	0
English	115	0	0
Bars	117	0	0
Straits	115	5	0
Australian	115	12	6
Eastern	119	2	6
Banca	118	12	6
Off. av. cash, July	111	11	1 1/16
Do., 3 mths., July	113	9	7 15/16
Do., Sttlmt., July	111	11	3 1/16

SPELTER.

	£	s.	d.
Ordinary	11	7	6
Remelted	10	5	0
Hard	8	5	0
Electro 99.9	13	7	6
English	11	10	0
India	10	10	0
Zinc dust	19	0	0
Zinc ashes	2	15	0
Off. aver., July	12	10	9 1/16
Aver. spot, July	12	5	7 5/16

LEAD.

	£	s.	d.
Soft foreign ppt.	11	12	6
English	13	0	0
Off. average, July	12	16	3 1/16
Average spot, July	12	14	7 1/16

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	20	0	0
Do., V.M. ex-whf.	19	5	0
Rods	22	0	0
Boiler plates	14	0	0
Battery plates	15	15	0

ANTIMONY.

	£	s.	d.
Special brand, Eng.	34	0	0
Chinese	22	0	0
Crude	21	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	16	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

	£	s.	d.
Ferro-silicon—			
25%	7	7	6
45/50%	10	7	6
75%	15	2	6
Ferro-vanadium—			
35/50%	12/8 lb Va.		
Ferro-molybdenum—			
70/75% c. free	4/2 lb. Mo.		
Ferro-titanium—			
23/25% carbon-free	9½d. lb.		
Ferro-phosphorus, 20/25%	£15	10	0
Ferro-tungsten—			
80/85%	1/8½ lb.		
Tungsten metal powder—			
98/99%	1/11½ lb.		
Ferro-chrome—			
2/4% car.	£27	10	0
4/6% car.	£21	2	6
6/8% car.	£20	10	0
8/10% car.	£19	15	0
Ferro-chrome—			
Max. 2% car.	£29	10	0
Max. 1% car.	£33	12	6
Max. 0.70% car.	£35	10	0
70% carbon-free	9½d. lb.		
Nickel—99%	£170 0 0 to £175	0	0
Ferro-cobalt	8/9 lb.		
Aluminium 98/99%	£85	0	0
Metallic chromium—			
96/98%	2/7 lb.		
Ferro-manganese (net)—			
76/80% loose	£10 15 0 to £11	5	0
76/80% packed	£11 15 0 to £12	5	0
76/80% export	(nom.) £ 9	0	0
Metallic manganese—			
94/96% carbonless	1/3 lb.		

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—

Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/32 in.	1/– lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/– lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales							
Heavy steel					2	0	0
Bundled steel and shrngs.	1	14	0	to 1	17	6	
Mixed iron and steel	1	15	0	to 1	17	0	
Heavy cast iron					2	2	6
Good machinery for foundries					2	5	0
Cleveland—							
Heavy steel					1	17	6
Steel turnings					1	5	0
Cast-iron borings					1	2	0
Heavy forge					2	10	0
W.I. piling scrap					2	2	6
Cast-iron scrap	2	0	0	to 2	2	0	
Midlands—							
Light cast-iron scrap					1	17	6
Heavy wrought					2	5	0
Steel turnings, f.o.r.					0	15	0
Scotland—							
Heavy steel					1	17	6
Ordinary cast iron					2	2	6
Engineers' turnings					1	5	0
Cast-iron borings					1	10	0
Wrought-iron piling					2	7	6
Heavy machinery					2	7	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	26	0	0
Brass	18	0	0
Lead (less usual draft)	10	0	0
Tea lead	7	0	0
Zinc	5	10	0
New aluminium cuttings	52	0	0
Braziery copper	23	0	0
Gunmetal	23	0	0
Hollow pewter	72	0	0
Shaped black pewter	53	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/–
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/–
Hematite No. 1	61/6
Hematite M/Nos.	61/–
N.W. Coast—	
Hem. M/Nos. d/d Glas.	71/6
„ d/d Birm.	84/6
Malleable iron d/d Birm.	115/–
Midlands—	
Staffs common*	—
„ No. 4 forge*	61/–
„ No. 3 fdry.*	66/–
Shrops basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	57/6
„ fdry. No. 3*	62/6
„ fdry. No. 1*	65/6
Derbyshire forge*	61/–
„ fdry. No. 3*	66/–
„ fdry. No. 1*	69/–
„ basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	73/6
„ No. 3	71/–
Hem. M/Nos. d/d	70/–
Sheffield (d/d district)—	
Derby forge	58/6
„ fdry. No. 3	63/6
Lincs forge	—
„ fdry. No. 3	63/6
E.C. hematite	76/–
W.C. hematite	81/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/–
„ fdry. No. 3	67/–
Staffs fdry. No. 3	67/–
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/–
Dalzell, No. 3 (special)	102/6 to 105/–
Glengarnock, No. 3	87/– to 87/6
Clyde, No. 3	87/– to 87/6
Monkland, No. 3	87/– to 87/6
Summerlee, No. 3	87/– to 87/6
Eglinton, No. 3	87/– to 87/6
Gartsherrie, No. 3	87/– to 87/6
Shotts, No. 3	87/– to 87/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	9	15	0	to 10	0	0	
Nut and bolt iron	8	5	0	to 8	10	0	
Hoops	10	10	0	to 12	0	0	
Marked bars (Staffs) f.o.t.				12	0	0	
Gas strip	10	10	0	to 12	0	0	
Bolts and nuts, ¾ in. × 4 in.				12	5	0	
Steel—							
Plates, ship, etc.	8	15	0	to 8	17	6	
Boiler plts.	9	0	0	to 9	15	0	
Chequer plts.				10	7	6	
Angles				8	7	6	
Tees				9	7	6	
Joists				8	15	0	
Rounds and squares, 3 in. to 5½ in.				9	7	6	
Rounds under 3 in. to ¾ in. (Untested)				6 12 6 & up.			
Flats—8 in. wide and over				8	12	6	
„ under 8 in. and over 5 in.				8	17	6	
Rails, heavy	8	5	0	to 8	10	0	
Fishplates				12	0	0	
Hoops (Staffs)				9	5	0	
Black sheets, 24g.	8	0	0	to 9	0	0	
Galv.cor.shts.24g.	9	5	0	to 9	10	0	
Galv. flat sheets	9	15	0	to 10	0	0	
Galv. fencing wire, 8g. plain				12	0	0	
Billets, soft	4	17	6	to 5	5	0	
Billets, hard				6	12	6	
Sheet bars	4	12	6	to 4	17	6	
Tin bars				4	12	6	

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	11½d.
Rods	11½d.
Tubes	1/6d.
Castings	11½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
5% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
3/– to 10 g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	17.01
No. 2 foundry, Valley	17.00
No. 2 foundry, Birm.	12.00
Basic	17.26
Bessemer	18.76
Malleable	18.76
Grey forge	18.26
Ferro-mang. 80%	85.00
O.-h. rails, h'y, at mill	43.00
Billets	29.00
Sheet bars	29.00
Wire rods	35.00
	Cents.
Iron bars, Phila.	2.09
Steel bars	1.60
Tank plates	1.65
Beams, etc.	1.65
Skelp, grooved steel	1.60
Skelp, sheared steel	1.65
Steel hoops	1.80
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	2.90
Wire nails	1.80
Plain wire	2.20
Barbed wire, galv.	2.55
Tinplates, 100-lb. box	$5.00

COKE (at ovens).

Welsh foundry	22/6 to 25/–
„ furnace	14/– to 15/–
Durham and Northumberland—	
„ foundry	13/– to 14/–
„ furnace	13/–
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	13/1½ to 13/3
„	28×20 „	26/6
„	20×10 „	19/1½
„	18¾×14 „	14/–
C.W.	20×14 „	12/9
„	28×20 „	25/6
„	20×10 „	18/10½
„	18¾×14 „	14/–
Terneplates	28×20	26/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

	£	s.	d.		£	s.	d.
Pig-iron	6	0	0	to £7	0	0	
Bars, hammered, basis	£16	10	0	to £17	0	0	
Bars and nail-rods, rolled, basis	£15	17	6	to £16	5	0	
Blooms	£10	0	0	to £12	0	0	
Keg steel	£32	0	0	to £33	0	0	
Faggot steel	£18	0	0	to £23	0	0	
Bars and rods dead soft, st'l	£10	0	0	to £12	0	0	

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Current Discounts.

	Tubes.	*Fittings.*
Gas	62½%	57½%
Water ..	58½%	52½%
Steam ..	55%	47½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Aug.	13 ..	32	11	3	inc.	3/9
,,	14 ..	32	15	0	,,	3/9
,,	17 ..	32	18	9	,,	3/9
,,	18 ..	32	8	9	dec.	10/-
,,	19 ..	32	8	9	No	change

Electrolytic Copper.

		£	s.	d.		
Aug.	13 ..	35	0	0	No	change
,,	14 ..	36	0	0	inc.	20/-
,,	17 ..	36	0	0	No	change
,,	18 ..	35	10	0	dec.	10/-
,,	19 ..	35	10	0	No	change

Standard Tin (cash).

		£	s.	d.		
Aug.	13 ..	115	17	6	inc.	12/6
,,	14 ..	116	0	0	,,	2/6
,,	17 ..	115	10	0	dec.	10/-
,,	18 ..	114	7	6	,,	22/6
,,	19 ..	113	17	6	,,	10/-

Tin (English ingots).

		£	s.	d.		
Aug.	13 ..	117	0	0	inc.	10/-
,,	14 ..	117	5	0	,,	5/-
,,	17 ..	116	10	0	dec.	15/-
,,	18 ..	115	10	0	,,	20/-
,,	19 ..	115	0	0	,,	10/-

Zinc Sheets (English).

		£	s.	d.		
Aug.	13 ..	20	0	0	No	change
,,	14 ..	20	0	0	,,	,,
,,	17 ..	20	0	0	,,	,,
,,	18 ..	20	0	0	,,	,,
,,	19 ..	20	0	0	,,	,,

Spelter (ordinary).

		£	s.	d.		
Aug.	13 ..	11	5	0	dec.	2/6
,,	14 ..	11	3	9	,,	1/3
,,	17 ..	11	1	3	,,	2/6
,,	18 ..	11	0	0	,,	1/3
,,	19 ..	11	7	6	inc.	7/6

Lead (English).

		£	s.	d.		
Aug.	13 ..	13	5	0	No	change
,,	14 ..	13	0	0	dec.	5/-
,,	17 ..	12	15	0	,,	5/-
,,	18 ..	12	15	0	No	change
,,	19 ..	13	0	0	inc.	5/-

Imports and Exports of Iron Castings in July and the seven months 1931, compared with July and the seven months 1930.

	July, 1930.	July, 1931.	Seven months, 1930.	Seven months, 1931.	July, 1930.	July, 1931.	Seven months, 1930.	Seven months, 1931.
Imports.	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Pipes and Fittings, Cast	1,192	1,583	13,090	8,073	14,589	17,672	158,050	101,956
Castings, in the Rough, Iron	139	119	1,413	1,019	2,682	2,125	31,140	20,386
,, ,, ,, Steel	987	511	8,920	3,656	23,688	11,032	210,300	78,181
Hollow-ware, Cast, not Enamelled	3	14	20	52	282	855	2,069	3,559
,, ,, Enamelled	—	5	16	42	—	285	929	1,998
Exports.								
BUILDERS' CASTINGS—								
To Argentine Republic	142	57	1,315	545	9,605	2,413	58,877	23,975
,, British South Africa	313	249	1,400	1,209	11,328	8,456	55,000	46,530
,, ,, India	146	66	933	789	5,397	2,307	34,424	27,396
,, Australia	8	5	231	60	362	192	13,525	2,788
,, New Zealand	74	22	627	257	3,763	2,209	36,548	16,727
Total (including other countries)	1,529	1,214	10,407	7,644	67,610	52,964	463,657	341,444
PIPES AND FITTINGS—CAST—								
To Argentine Republic	1,431	152	9,976	3,535	14,281	1,802	97,432	34,422
,, British South Africa	592	493	4,856	5,170	7,209	6,766	55,169	60,995
,, ,, India	241	89	2,022	943	4,949	1,631	31,096	16,813
,, Straits Settlements and Malay States	1,485	1,016	4,682	1,917	11,862	8,230	41,885	20,627
,, Ceylon	67	144	910	495	697	1,469	9,202	6,258
,, Australia	51	11	561	105	1,110	302	10,258	2,237
Total (including other countries)	9,077	7,709	70,529	44,785	107,037	89,774	790,103	513,329
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	360	187	2,466	1,341	12,110	6,926	79,893	46,689
,, Enamelled	107	47	482	317	8,854	4,445	41,786	31,253
CASTINGS, in the rough—								
Iron	195	490	1,450	1,667	6,472	5,740	44,342	35,311
Steel	161	94	1,298	824	6,006	3,896	51,992	28,849

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XUM

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

AGENTS, on commission basis, for the South, Midlands and Scotland, with good foundry connections, wanted for the sale of a high-grade Core Oil for green standing cores, and a Desulphurising Powder.—Please address offers, with references, to F. L. de Bruin, Neuss o/Rhine, Germany.

SALESMAN (whole- or part-time) required by strong financial company interested in Foundry Equipment. Knowledge of foundry trade preferred.—Write, stating full particulars, to Box 864, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of The Foundry Trade Journal.

Any Member, Associate Member or Associate of the Institute of British Foundrymen who desires his qualifications to be inserted in the column must forward to the General Secretary of the Institute the following information:—(a) Name and address; (b) name of present employer (or last employer if unemployed); (c) brief particulars of qualifications, experience, and type of position required. The name will not be disclosed until the candidate is in communication with a prospective employer. Announcements will be inserted in two successive issues, unless announcers' requirements have been met with in the meantime.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

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Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester.

YOUNG Foundryman, good general and technical education, requires position. Has served full apprenticeship, worked as moulder, and has held position as assistant to foundry manager. (139)

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YOUNG Steel Moulder with sound, up-to-date experience, requires supervisory position. Knowledge of quoting, piecework or day-work. (141)

ENGINEERING and Repairing Works Manager requires similar position or as Representative. Works, drawing office, and commercial training. Has held present post as works manager for several years. Excellent commercial connection. (142)

AGENCIES.

WELL-KNOWN firm of Iron and Steel Merchants, with extensive connections in the Midlands, are desirous of increasing their activities and would welcome correspondence with blast furnaces and reputable manufacturers of foundry equipment, with a view to representation in the Midland Counties.—Box 866, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

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TO Engineers, Founders, Manufacturers.—Fine site of nearly three acres on arterial road, with Foundry and Workshops and own Rail Sidings into the premises. Modern Offices, Warehouses and Workrooms. Central Heating.—Charles A. Tricks & Son, Auctioneers, St. Nicholas Street, Bristol.

MACHINERY.

SAND MIXERS.—New and Secondhand. Ask us to quote.—W. Brealey & Company, Limited, Station Works, Ecclesfield, Sheffield.

INGERSOLL-RAND Portable Sets, one 9-in. x 8-in. type, 20,250 cub. ft., one 7-in. x 6-in. type, 20,160 cub. ft. Ready for immediate service. Sale or hire, deferred terms if wanted.—A. Hammond, 14, Australia Road, Slough.

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MISCELLANEOUS.

GANISTER, best quality for cupolas, also for Steel Works.—Asbury Silica Company, "The Brooms," Park Lane, Congleton.

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MISCELLANEOUS—*Continued.*

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4 ft. 6 in. "Evans" Sandmill ...	£20
6 ft. "Jackman" Sandmill ...	£38
Jackman Rotary Sifter	£8
"Macdonald" Pneumatic Sifter	£11

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PETER—WITH ONE EXCEPTION

With one exception Peter is an ordinary little fellow. Chubby, likeable, just five-and-a-half, full of life and fun, and on occasions—be it admitted—of naughtiness. Just now Peter's rather important, for this is his first term at school, and he's grappling with the intricacies of "A B C" and "Twice-Two": difficult subjects to all men of five-and-a-half, but even more difficult in Peter's case because—bad luck—he's totally blind. That's his One Exception. Peter learns reading, writing, and 'rithmetic through the medium of "Braille"—dull stuff compared with the coloured picture books of most five-and-a-halfs. However, he's a stout lad is Peter, and he's making great progress.

Would you like to know more about him? How, in spite of his "One Exception," he is being educated and, when older, technically trained and usefully employed. There is a long waiting list of "Peters" throughout the British Isles, for whom training and accommodation must be provided in the immediate future.

Will you help with a donation or annual subscription? Any sum, large or small, will be gratefully received.

Here's a suggestion. Your eyesight is worth 3d. a year to you. Send Peter and his handicapped pals 3d. for every year you've had it. Now, please, in case it slips your memory. Good idea?

The Chairman,

SCHOOL FOR THE BLIND
(Founded 1838)
SWISS COTTAGE, LONDON, N.W. 3